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ARMATURES OF GRAMME DYNAMOS.

Mr. DUGALD JACKSON'S paper on the above, which we reproduce in our present issue, is full of interest to manufacturers and designers of dynamos. The ratio between the cross sections of the armature and magnets has a different value in almost every type of machine, and an examination of the proportions adopted in practice reveals the fact that absolute uniformity of opinion regarding this point has not yet been reached. We do not quite follow Mr. Jackson when he says that increase of cross section in the Gramme armature brings with it increased mechanical difficulties, for we believe that any difficulties introduced can be readily surmounted; nor should we compare the cross section of drum armatures with that of ring armatures, since considerations quite different influence their design.

In the Siemens armature, the opening in the centre need be only slightly larger than the shaft, and it so happens that when the external diameter is sufficient to receive all the convolutions, we have a cross section which in an armature of the Gramme type would be considered excessive, and which from a magnetic point of view is more than requisite for the conduction of force lines. With the Gramme armature it is different. Here we have to settle first the diameter of the interior opening, so that the conductors passing through it have sufficient radiating surface and efficient ventilation, and obviously the armature is heavier and the periphery speed greater as we increase the thickness of the core. It is with armatures of the Gramme type that Mr. Jackson's paper deals, the results obtained from his experiments being instructive as well as interesting.

In this country the ratio of armature to field magnet cross section varies greatly in the ring-wound machines of different makers. In Mr. Crompton's machines, and also in those designed by Mr. Kapp eighteen months ago, the ratio was about 1 to 2, the density of the lines of force in the armature being consequently greater than in any other machines. It is questionable whether the best result is obtained by working with such high densities, for it is evident from Mr. Jackson's experiments that as we go on increasing the section of the armature we get an advantage worth having up to a certain point, the field produced by a given excitement continuing to increase. The armature having only from one-fifth to one-tenth of the total weight of machine, an increase in its weight does not greatly increase the total, and hence its cross section ought to be increased until we get for a given section of field magnet the maximum economic induction.

If by increasing the ratio of armature to magnet section, say, from ·5 to ·75, we get 20 per cent. increase in the induction, as Mr. Jackson appears to have done, we can obviously greatly improve our machines, although the density of the lines of force in the core is reduced by doing so to about three-fourths of its former value. The out-put will be increased by 20 per cent., and the efficiency raised, for in a machine of usual proportion the smaller dimension of the core only will be modified, and the length of wire on the armature will not be 20 per cent. greater. The increase in the total weight of machine will be much under 20 per cent. probably 15, so that all things considered we get a decided gain by diminishing the density of the lines of force in the armature. In the later machines of Mr. Kapp we believe the cross section of the armature has been increased until the ratio is 1 to 1·5 in those for incandescence lighting, this being rather less than that deemed by the American engineers the best proportion. Mr. Esson has shown that for a given excitement, up to a certain limit the lines of force passing through the armature increase directly as its cross section; afterwards they increase less rapidly until a point is reached where there appears to be for a farther increase of section no corresponding advantage. Resulting from experiments in this direction, he has adopted in the "Phœnix" machine a ratio of armature to magnets varying from ·7 to ·75, the economic limit being reached earlier in this case than in Mr. Jackson's experiments. Curve 2 exhibits clearly the results obtained by the latter experimenter, there being shown a very decided gain by increasing the armature section much over the ratio above given. In the later Goolden and Trotter dynamos the ratio is about ·7, and in the "Victoria" and "Manchester" machines ·66 and ·6 respectively. The two-pole Gülcher machine has an armature of cross section about equal to that of the magnet, while in some of the Elwell-Parker machines we believe the ratio exceeds ·8. Notwithstanding these great variations among different types, it seems that the usual proportion lies mostly between ·6 and ·7, only in a few cases is the latter exceeded or the former reduced.

A glance at the curves in fig. 1 shows that along with the advantage of a greater out-put in armatures of large cross section, there goes the additional advantage that the machine can be more readily compounded for constant potential. The sharp bend so conspicuous in the No. 1 is absent in the No. 5 curve, and it follows that when compounded the curve of potential in the latter will more nearly resemble a straight line than in the former. The excitement supplied by the series winding will be less with the armature of large section than with the smaller one, the proportion between the shunt and series wire being of course different for each different ratio.

Though admitting the importance of Mr. Jackson's results, we are of opinion that nothing less than actual trial with armatures of different section wound and run in machines will tell us the whole truth about this matter. The experiments undoubtedly teach us something regarding the law of the electro-magnet under conditions of varying armature section, but they do not show us the actual characteristics of machines under

these conditions where cross magnetisation plays necessarily an important part. It is very unlikely that in a series dynamo the characteristics obtained from large section and small section armatures respectively would show in their E.M.F.'s the same relation as do the curves of magnetisation when no current flows round the armature. We should naturally expect that the cross magnetisation produced by the large section armature would have an effect on the field greater than that produced by the small section armature, and this is a reason why in actual dynamos the limit to increase of section may be reached sooner than the experiments of Mr. Jackson would lead us to imagine. We are not aware that any experiments have been published to illustrate this point, but if any of our readers have made them we shall be glad to hear from them. The subject is an important one, and we hope that Mr. Jackson's researches will lead to some interesting discussion in our columns.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 537.)

VOLT AND AMMETERS—*Continued.*

THERE are several instruments which do not belong to any of the classes discussed above. Of these Captain Cardew's voltmeter is the most important. In this a fine wire is heated by the current and its expansion is measured. The Cardew voltmeter has undergone many improvements since it was first brought out. What is called the "Admiralty" pattern will be described first. This is shewn in fig. 13. This is a general diagram, and is not absolutely correct in every detail. What is known as the "Admiralty" type is generally vertical, but in the figure the instrument is shewn horizontal, thus embodying the latest improvements.

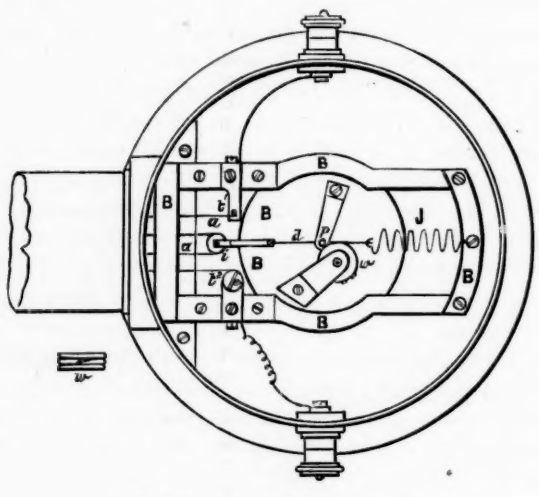


FIG. 13.—CARDEW'S VOLTMETER.

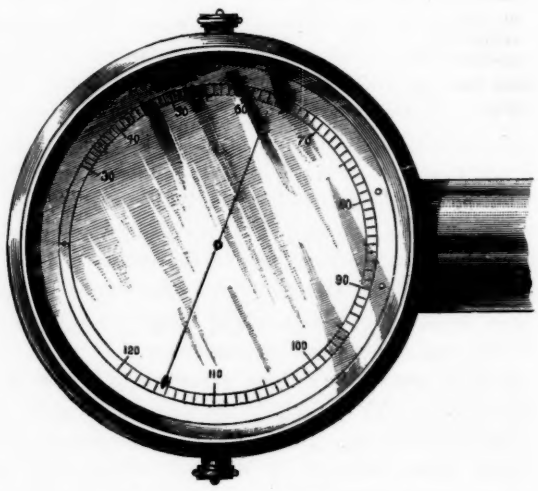


FIG. 14.—CARDEW'S VOLTMETER.

The wire, *a*, *a*, is stretched inside a long tube. It starts from t^1, which is connected with one terminal, and is stretched along the inside of the tube, and passes over a small ivory pulley and returns to *i*, which is connected with the spring, J. After passing over the ivory pulley, *i*, it is led to the other end of the tube again, over another pulley, and back to t^2. There are thus four wires passing through the tube. The ivory pulleys at the end of the tube are attached to a casting which is fixed on the ends of two rods. This arrangement is to enable the wire to be threaded easily, as the tube or outer case can be removed without interfering with the adjustment of the wire. The wire is doubled backward and forwards to get a greater length, and thus a higher resistance. As far as the expansion is concerned, it is that of two lengths of wire, and the pull of the spring, J, is against two thicknesses of wire. The pulleys at the end of the tube are made to run with very little friction, and are carefully pivoted in jewel holes. The friction of the pulley, *i*, is not so important, as that the expansion of the two loops of wire should be the same. I is attached to the wire, *d*, which is wound round a pulley, *w*, which is turned with two grooves. The wire passes from one groove into the other between two screws as shewn in the side view of the pulley. This prevents the wire slipping relatively to *w*. It passes on to the spring, J. The spring, J, is simply to keep the wire, *a*, *a*, taut. The readings do not at all depend on the strength of the spring, as it is too weak to be able to stretch the wire in the least. A little toothed wheel is attached to the pulley, *w*, and gears into the pinion, *p*, to which the index is attached. In the earlier forms of instruments the spring was attached to a pulley of different diameter from that to which *d* was fixed; the result was that there was a strain on the arbor of *w*, which caused friction at the pivots. The wire for this type for 120 volts is ·0025 in. in diameter, and is of platinum silver; the resistance is about 30 ohms per foot. This instrument takes 40 watts at 120 volts. Though this is high, it must be remembered that this voltmeter has no temperature errors like those of electro-magnetic instruments. The temperature of the wire is in practice about 200° C. at the higher readings. The reading evidently does not depend on the absolute expansion of the wire, but on the relative expansion of the wire and bars. The bars are therefore made of steel for part of their length, and brass the rest, so that they have the same coefficient of expansion as the wire. If it were not for this, the instrument if set to zero at one temperature would not come to zero at another. The rod arrangement has a slight error, because, as the rods do not entirely envelop the wire, the wire coils cool more quickly than the rod, so that if the instrument after reading 120 volts or so, is used to read 20 or 30 volts, the wire is colder than it ought to be relatively to the rods, so that the instrument reads too low.

Though the instrument is compensated for temperature as regards the lengths of the rods and wire, there is another source of small errors; and that is the rise of resistance of the wire when the voltmeter is used in a very hot room, or it falls if the room is cold. This error amounts to about 1·6 per cent. between 0° and 50° C. The makers propose to add a little rheostat and a thermometer, so that this error can always be corrected. If it is known before hand that the instrument

is going to be used, for instance, in an engine room at say 80°, it can be calibrated for use at that temperature. As the zero is apt to be altered by rough usage or shaking, the end of the wire, t_2, is attached to an adjusting screw, so that the little wire can be taken in or let out without interfering with the rest of the instrument. The 60-volt type is much the same as the 120-volt, except that the wire is shorter and thicker. The power emitted by a given surface is obviously less with a thick wire than with a thin, because the heat is carried away largely by convection and conduction. The surface of the wire and the power spent are the same as in the 120-volt instrument, but the wire is shorter, being 8 feet instead of 12 ; the wire, therefore, reaches a higher temperature, and the expansion is the same as in the long wire voltmeter. The object of using the rods to support the wire is to overcome the difficulties of stringing the wires, and of taking the voltmeter to pieces to examine or repair it without necessitating recalibration ; but, as explained, they cause a small error. This difficulty has been surmounted by the following ingenious device. A temporary rod is screwed in and the wire is strung and arranged. The little casting to which the ivory pulleys are attached is then screwed to the outer tube. The rod is then removed. The outer tube is made of iron and brass so as to compensate for temperature. A short piece of very fine wire is put in circuit to act as a fusible cut-out, though a sudden rise of temperature will often fuse both wires. The whole mechanism is fixed to a brass framework, B, B, as the old wooden cases were found to warp and alter.

The Cardew voltmeter has always been used vertically till lately, and the little convection currents inside the tube cause the index to keep moving so that a reading cannot well be taken within 1½ per cent. This difficulty is quite got over by putting the instrument horizontally. This simple, but valuable modification, is due to Mr. Ram. Prof. Ayrton had also found out the same thing. Of course the instrument must be calibrated in the horizontal position ; those who possess vertical voltmeters must not turn them on their sides and expect them to be accurate. A horizontal voltmeter can be read within ¼ per cent. through its ordinary range. These voltmeters are very carefully calibrated, and a curve of each is taken, and the readings are transferred to a dial by a special apparatus and engraved. The expansion of the wire practically follows a simple law, but each instrument is calibrated throughout its scale. The Cardew voltmeters above described are made by Messrs. Goolden and Trotter. Prices, £8 8s. to £10 10s. Messrs. Paterson and Cooper also make Cardew voltmeters, but they differ considerably in details of construction. Their price is £8 8s.

Captain Cardew has devised a standard instrument which has no friction and an optical arrangement for reading, but as it is more a laboratory than a workshop instrument, it need not be described here.

The Cardew voltmeter is free from most of the usual errors. The chances of error can only lie in the wire itself, which may gradually alter in resistance. It does not seem to do this, however, measurements taken after a year's constant use showing no change. The voltmeters are overrun before calibration, as a precaution.

M. Lalande has lately brought out an instrument which is a sort of electro-magnetic hydrometer. It consists of a coil or solenoid with a glass tube in the centre ; this contains water or some other liquid, in which floats a small hydrometer with a soft iron rod enclosed in it. This idea is really very old, as Iremonger brought a hydrometer ammeter before the Electrical Society somewhere about 40 years ago. The difficulty with such an instrument is in getting a long range, though no doubt it may be, and probably is, done by properly shaping the solenoid and core. It may be easier to make such an instrument sensitive through a small range, which is what is wanted for installation work. Messrs. Sharp and Kent make the "Lalande" ammeters and voltmeters.

For very high electromotive force it is generally best to use an electrometer, as it takes no current to work it. Of course, a high-resistance voltmeter may be used, but it is impossible to make a coil for commercial use whose insulation will stand, for instance, 2,500 volts. If a voltmeter had a certain number of ampère turns at, say, 100 volts, and the wire was, say, 10 mils., the diameter for 2,500 volts would be 2 mils., and the coil would get hot, because so much space would be taken up by the insulation. External resistance can be added in series instead of being wound on the coil, and this is, perhaps, the best way of working in many cases. The drawbacks are that the voltmeter and its resistance will absorb a great deal of power, and that it is dangerous to work with such high electromotive forces, as it would be easy to get a fatal shock by disconnecting the wires from the voltmeter and retaining the ends in the hand. For this reason, it is better to use an electrometer, though most electrometers are anything but workshop instruments. An electrometer should be connected with a dynamo or leads by circuits which contain some damp string or a carbon megohm, or some other very high resistance, so that if anyone does accidentally touch the terminals, the current through will be too small to do any harm.

Sir William Thomson has lately brought out a gravity electrometer. This was described and illustrated in this Journal (May 27th), so it is unnecessary to describe it again.

The ordinary torsion electrometer is sometimes used for measuring high potentials in practical work. The needle and one pair of quadrants are connected to one terminal, and the other quadrant is connected to the other terminal. The force then acting on the needle is as the square of the difference of potential. When the difference of potential is too small to give good deflections so arranged, a permanent battery of little cells is connected to one pair of quadrants and the needle, while the dynamo is connected to the two pairs of quadrants, and not to the needle directly. The force is then as the difference of potential, and not as its square. However, the only use for electrometers in direct-current work is in arc light installations, and an electrometer is not the sort of thing an electrician in charge of an installation would take to as a rule, as he would much prefer to work with an ammeter only, and let the electromotive force take care of itself.

Mr. Arthur Wright has made and used for some time an ingenious electrometer. It consists of a fixed and a movable plate. The latter is supported on an arbor which turns very freely and is not quite vertical, so that the plate tends to move into one position. The planes of the plates are not quite parallel, so that the attraction turns the movable plate so as to bring it nearer the other. This instrument is chiefly used for localising leaks. By measuring the difference of potential between the terminals of the machine, and between each terminal and the earth the position of a fault can be localised with considerable accuracy.

There are many instruments, such as Weston's, Lippmann's &c., which have not been described. They have been omitted because they are not well known, or in general use in this country. There are also many which are still in the experimental stage or are laboratory instruments only.

(*To be continued.*)

IMPROVEMENTS IN INCANDESCENT LAMPS.

MESSRS. R. KENNEDY and R. DICK have recently patented some improvements in incandescent lamps. These improvements consist of a carbon conductor of short length and low actual resistance (under 100 ohms), but of a high specific resistance and homogeneous without any outer deposit of graphitic carbon, and attached to electrodes or wires so arranged within the containing glass bulb that in the event of the carbon conductor getting injured or failing to act, the electrodes or wires are automatically cross-connected to prevent the interruption of the current to and through the remaining lamps of the circuit.

To prepare a carbon conductor for incandescent electric lamps, a carbon-forming vegetable or textile material or fibre (preferably "Kitool," a natural grass or plant fibre) is drawn to a round or other uniform section or thickness through cutting dies. This dressed fibre is then placed in a copper or other ductile metal drawn tube, which loosely fits it; the copper tube is then drawn down successively through the slightly decreasing holes of a draw plate until the tube compresses the fibre within it; this compressing of the fibre is carried on as far as possible without breaking it by the excessive drawing of the copper tube. The tube is then cut into suitable lengths, and the lengths bent into the desired shape of the carbon conductors as required; after thus shaping these they are packed into crucibles in a muffle or other closed furnace where no air can get at them, and raised gradually to a white heat until the conductors are quite carbonised within the tubes they are so drawn and shaped in.

The effect of the carbonisation of the fibre under this high compression within the tube is to produce carbon conductors of such perfect uniformity of section, density, and surface, that there are so few defects in them that the shorter lengths required may be nearly wholly utilised with but little waste, as these carbons are not subject to the same amount of irregularities and faults inherent in the ordinary long thin filaments made with little or no compression during carbonisation. Thus the improved carbons do not require filling up or repairing by depositing and flashing, which is absolutely necessary in the making of the said ordinary long thin filaments.

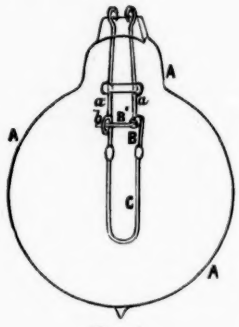


FIG. 1.

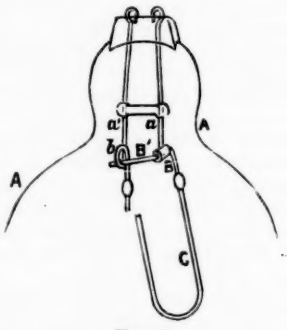


FIG. 2.

The fibres are extracted from the copper tube after carbonisation by dissolving the copper off them in a suitable acid, after which they are washed and dried and cut into lengths (ascertained by measuring their electric resistance) ranging from a quarter of an inch to three or four inches, according to the size and luminosity of light desired.

After being thus prepared and carbonised, the carbon conductors are mounted on platinum electrodes in a usual manner, and tested in a partial vacuum (or in an inert gaseous atmosphere, in which the gas does not combine with them); they are afterwards sealed into bulbs of glass which are exhausted by air and Sprengel pumps in the usual manner. When the lamps are being exhausted, in some cases vapours of chlorine are admitted to combine with and remove any hydrogen remaining in the carbon conductors.

The arrangement for automatically short-circuiting the electrodes of a lamp in the event of the failure of its carbon conductor, consists in forming an easy working joint lever on one (or both) of the electrodes, so that it will fall and complete the circuit when either limb of the carbon filament or conductor breaks.

The figures show how the idea is effected:—On the lower part of one of the fixed wires or electrodes, *a*, an L-bell crank, or other equivalent switch lever or wire, B, B^1, is jointed, and oscillates on this joint at the angle formed by the perpendicular and horizontal branches, B, B^1, respectively of the L-shaped wire. One end of the carbon filament or conductor, C, is rigidly jointed to the end of the perpendicular branch, B, which is the lower end, as shown in the figs., but would be the top when the lamp was inverted, and the horizontal branch, B^1, hangs over a lateral projection, which is preferably made in the form of a small loop, *b*, on the other electrode, a^1. So long as the carbon, C, is whole and sound, the L-shaped switch-piece, B, B^1, is fixed or maintained in the position shown in fig. 1, so that it does not touch the lateral projection or loop, *b*; but if the carbon, C, breaks, the L-shaped piece falls, and the horizontal branch, B^1, makes contact with the projecting piece, *b*, on the opposite wire, a^1, as shown in fig. 2, and thus short-circuits the two wires, *a*, a^1, and permits the electric current to pass to the other lamps in series or parallel arc, although the switch is not really necessary for working with the lamps ranged in parallel arc. And it will be seen that this switch connection, B, B^1, *b*, may be equally applied to any form of the electrodes or filaments, C, in incandescent or glow lamps placed in series order.

NEW MACHINE FOR ENGRAVING, DIVIDING, &c.

THE machine illustrated herewith has recently been placed in the market by Messrs. T. S. and W. Taylor, of Leicester; and marks a new departure in the methods

of engraving designs, letters, figures, &c., on metals, ivory, glass, vulcanite, and other materials. Besides surface engraving, and a variety of ornamental work and engine turning, the machine will do circular and straight dividing on flat, bevelled, or cylindrical surfaces; profiling and forming of irregular pieces of work from a copy, and will serve for many purposes of moulding, &c.

It has the advantages of great speed and accuracy, while no special skill is required to operate it.

Referring to the illustration, the material to be engraved is secured to the apparatus marked M in some convenient way, and may be moved about in all directions, and fixed in the best position for operating.

The work is done by revolving drills or cutters, carried in a cutter frame, which being supported by a hinged link, is free to move about in all directions in a horizontal plane. The cutter spindle is vertical, and driven by a gut band, either from a power shaft above, or by the treadle motion illustrated.

A copy of the design to be cut is fixed on the table, T, and is preferably a line engraving on hard wood, vulcanite, or metal.

For simple lettering and figures a standard hard

brass copy is set up in grooves in the table, after the manner of printers' type. The stylus, S, is moved by hand along the lines of the copy, and a system of levers forming in effect a common pantograph, guides the revolving cutter in a similar path over the surface to be engraved.

The apparatus shown is for reducing from a copy to various amounts, variable by the position of two sliders on the pantograph frame. The stylus is worked by the right hand, and the left hand used to feed the cutter by a milled nut. A stop keeps the depth of cut constant if necessary. The cutter runs at a high speed, and may be of any form suited to produce the required effect. For engraving on finished brass work, a simple flat double edged, or half round drill, leaves a clean brilliant cut free from burr, which may be left bright or coloured by suitable solutions.

Work to be filled with wax is effected with a long pointed drill, leaving the sides of the cut steep, and the bottom sufficiently rough to hold the wax. Iron and steel, ivory, wood, and vulcanite are worked with half round cutters. The section of the cut may be of any form; moulded, semi-circular, bevelled, rectangular, or dovetailed.

The mounting table shown is arranged for circular dividing. It may be moved in any direction, and fixed where necessary; a swivel joint being used for tubular and bevelled work. The work is clamped centrally on the table, which may be revolved by a tangent screw.

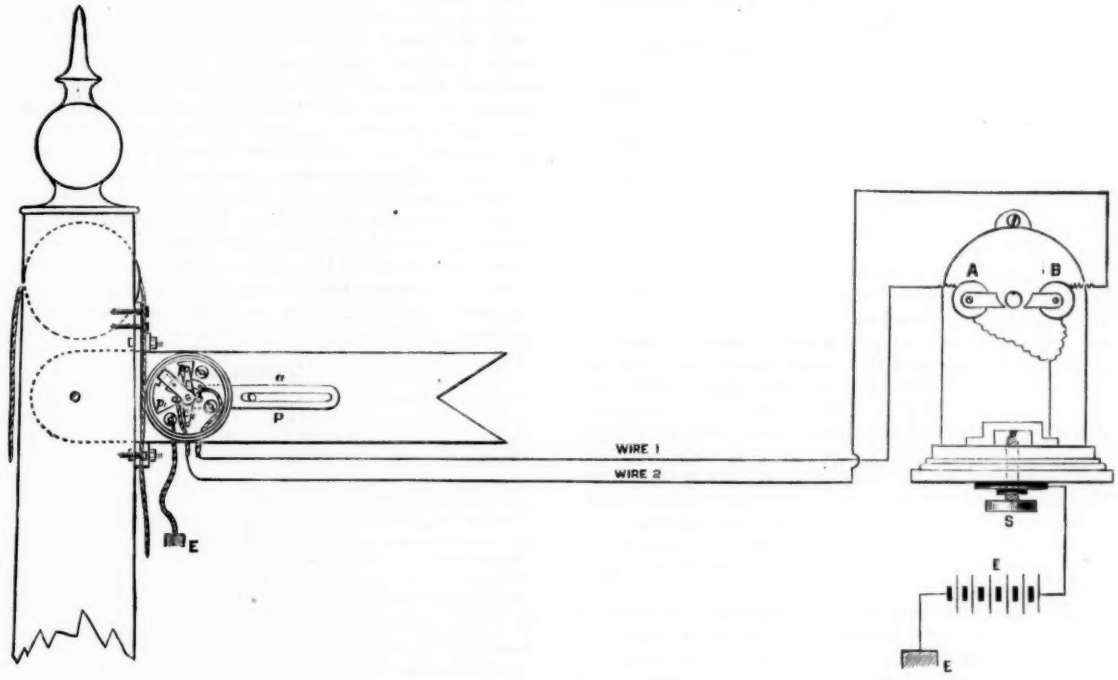
The number of teeth in the worm is suited to requirements, and when more than one number is necessary, changeable worms are adopted. Lines are marked by a simple point tool in the cutter spindle, the style being moved along a fixed straight guide. All necessary figuring and lettering may be done at the same setting of the machine.

GILBERT'S IMPROVED DISTANT SIGNAL REPEATER.

IN many forms of repeaters the commutator placed at the signal post works in direct connection with the rod or spindle of the distant signal; this arrangement is a very unsatisfactory and unreliable plan, as if by accident the crank at top in connection with the rod should break or work loose, the signal blade would fall to "clear" by gravity, whilst the repeater would not be disturbed, but still indicate danger, thus giving a false indication to the signalman. Although there are still a large number of cases in which such an arrangement is in use, it is by no means general; but it ought, we think, to be entirely prohibited by the Board of Trade.

In the repeater designed by Mr. A. E. Gilbert, Telegraph Superintendent of the Highland Railway Company, the commutator is fixed direct to the signal blade in a somewhat novel manner. The whole arrangement is shown by the fig.

At the signal post the commutator is firmly screwed to the post itself. It consists of an arm, a, with a slot in it; this arm is axled at the point, b, and on this axle is fixed the double arm, c, c_1. In the position shown, the arm, c, makes contact with the contact piece, p; when, however, the arm, a, is dropped through an angle of 45° or more, then the arm, c, moves off from p, and the arm, c_1, makes contact with the contact piece, p_1. The arms, c and c_1, being connected through the metal of the frame of the commutator with earth, it is obvious that with a in the position shown a current from battery E flows through the magnet coil, A, of the repeater signal, and *via* wire 1 to contact p, arm c, and thence to earth. When a is moved through an angle of 90° or more, then a current passes through magnet coil B *via* wire 2, to contact p_1, arm c_1, and thence to earth. If, however, the arm, a, is in an intermediate position, then arm c is off contact p, and arm c_1 is off contact p_1, consequently no current flows. The pin, P, fixed to the signal arm actuates the arm, a, but the latter being heavy would drop down, and bring c_1 in contact with p_1, should the signal arm break off. The action of the repeater signal through the medium of the magnet coils, A and B, is too obvious to require explanation. The screw, S', serves to disconnect the battery when the signalman leaves the signal cabin on the cessation of traffic, thus preventing a needless waste in the battery.



We may add that the repeaters are very substantially made, and are manufactured complete by Messrs. Tyer and Co., of Ashwin Street, Dalston Junction, and are largely used on the Highland Railway.

THE EFFICIENCY OF SMALL ELECTRO-MOTORS.*

By H. E. H. CLIFFORD, S.B.

THE following tests of electro-motors are presented as giving a good example of the efficiency of some of the smaller motors in use at the present day. They have been exclusively devoted to the determination of efficiencies, the subjects of governing and of smoothness of running under different loads being left out of consideration. The only other series of tests which have been published in this country, so far as I have been able to learn, are those made on motors and dynamos at the International Electrical Exhibition held at Philadelphia in 1884.†

The tests have been carried on in the Physical Laboratory of the Massachusetts Institute of Technology, during the years 1885–86, by Messrs. F. A. Pickernell, H. G. Pratt, D. P. Bartlett, and the writer—students at the Institute.

The number of machines tested was 13. I give below their names, together with either a brief description of their peculiarities or a reference to some publication in which they are described.

Griscom (S. P. Thompson's Dynamo-Electric Machinery, 2nd Ed., p. 429).

Ayrton and Perry (S. P. Thompson's Dynamo-Electric Machinery, 2nd Ed., p. 432).

Gramme-Machine à petite lumière (S. P. Thompson's Dynamo-Electric Machinery, 2nd Ed., p. 120).

Magneto Gramme (S. P. Thompson's Dynamo-Electric Machinery, 2nd Ed., p. 117).

Thompson (S. P. Thompson's Dynamo-Electric Machinery, 1st Ed., p. 354).

Deprez (Prescott's Dynamo-Electricity, p. 707).

Monarch.—An electro-magnet revolving within a ring-shaped electro-magnet, making use of consequent poles. The ordinary split-ring commutator is used.

Cleveland.—The armature, made up of two shuttle-wound armatures mounted on the same shaft, but placed at right angles to each other. This armature revolves in a strong field produced by two field magnets, wound so as to have consequent poles at their middle. Instead of brushes, four anti-friction rollers are used in connection with a four-part commutator. The pressure of the rollers is adjusted by springs.

Model Edison Dynamo.—A miniature machine of the Edison pattern, but series wound instead of shunt wound.

Diehl.—The field magnets are hinged at the yoke, so that the distance of the pole pieces from the armature is capable of adjustment. The armatures are made up of two Siemens shuttle wound armatures at right angles to each other on the same shaft. The motor is shunt wound. Two sizes were tested.

Hill.—The field magnets are placed below the armature, which revolves between cast iron pole pieces. The armature consists of a series of eight spools of wire arranged in couples, the axes of adjacent couples being at right angles to each other. The motor is series wound. Two sizes were tested.

The efficiency of a motor is equal to the horse-power delivered, divided by the rate of consumption of electrical energy by the motor. That is, if H P = horse-power delivered, C = current in ampères, E = electro-motive force in volts, as measured at the terminals of the machine.

$$\text{Efficiency} = \frac{\text{H P}}{\frac{\text{C E}}{746}}$$

The instruments used in the determination of C and E were Sir William Thomson's current and potential galvanometer. These had previously been carefully calibrated, and found to be correct to within 0·2 per cent. in the positions at which they were used in the tests. In cases where the compensating magnets had to be used, their intensity was carefully determined on each day of use, so that no material error should be introduced from this source. As far as possible, however, the use of the magnets was avoided.

For measuring the power given out by the smaller motors, a raw hide belt or a cotton cord was passed completely around a brass pulley on the motor shaft, the upper end being attached to a spring balance and the lower to a scale pan. By varying the weight in the scale pan the speed of the motor could be changed.

A Chatillon balance weighing to ½ oz. was used. In the tests on the magneto-gramme and the gramme, "à petite lumière," the machines were placed on a cradle dynamometer, a modification of the form devised by Prof. Brackett, of Princeton, and a dynamo machine was used as a friction brake. By closing the circuit of the dynamo through greater or less resistance, the work done, and consequently the power absorbed by the brake, could be varied.

In testing small motors great care must be taken in measuring the speed accurately. In these tests the speed indicator from a small siren was used. This was connected to the motor by an endless band passing from the pulley on the motor shaft to a pulley of the same diameter on the siren. The power required to run this indicator was excessively slight, and in computing the work done was neglected. The slip of the belt was negligible, as shown by numerous tests. With the magneto and gramme, "à petite lumière" a continuously recording engine counter was used, connected to the motor by means of a flexible spiral spring.

The following table gives, in parallel columns, the names of the motor tested, the current in ampères, the electromotive force in volts at the motor terminals, the activity in horse-power, the maximum efficiency and the speed for maximum efficiency in revolutions per minute :—

TABLE I.

Name of motor.	C.	E.M.F.	H.P.	Maximum efficiency.	Speed.
				per cent.	
Griscom	3·94	6·74	·006	17·0	1400
Ayrton and Perry	14·4	11·1	·082	38·4	831
Gramme "à petite lumière"	5·29	157·6	·945	84·5	2227
Magneto Gramme	12·6	27·4	·138	29·8	2067
Thompson	4·90	8·50	·012	21·7	2370
Deprez	4·74	10·4	·011	16·6	2140
Monarch	4·85	5·78	·004	10·1	578
Cleveland	6·78	12·0	·054	49·8	1360
Model Edison	0·82	90·5	·051	51·4	4065
Diehl, No. 1	7·65	16·5	·021	12·3	4180
Diehl, No. 2	6·12	15·1	·031	24·9	2480
Hill, No. 1	4·77	10·3	·010	14·8	2036
Hill, No. 2	5·04	15·1	·032	31·6	3030

The table succeeding gives the tests in full made on the Model Edison dynamo, and illustrates very well the relation of speed and efficiency. This machine is built somewhat after the style of the old Edison Z machine. It is series-wound, and has about the resistance, hot, of an Edison incandescent lamp, old style. The dynamo is an exceedingly neat and smooth-running machine. The motor runs without vibration and with no sparking, and heats up but very little, even at the highest speeds. It has been run for two minutes at a speed of 10,000 revolutions per minute. The great speed here obtained by such simple means, together with the readiness with which it can be varied within wide limits, indicate the availability of such a motor in any physical experiments in which a great speed of revolution is needed, as in studies of the velocity of light, the duration of the electric spark, &c.

One of the chief advantages derived from the use of electro-motors is the small weight per horse-power developed. The motors, which we have tested with one exception, the Gramme machine, "à petite lumière," have been intended for doing any light work, and the efficiency exhibited is not, of course,

* Read at a meeting of the American Academy of Arts and Sciences, March 9th, 1887.

† Reports of Examiners of Section XXIX., Supplement to the Journal of the Franklin Institute, March, 1886.

TABLE II.

Revolutions per minute.	Electromotive force in volts.	Current in ampères.	Horse-power put in.	Horse-power taken out.	Efficiency per cent.
1715	75·8	1·05	·1070	·0278	26·0
1934	75·6	·987	·1000	·0290	29·0
2372	77·4	·942	·0978	·0320	32·7
2414	75·6	·892	·0904	·0306	33·6
2748	75·6	·835	·0846	·0312	36·9
2895	75·6	·807	·0817	·0310	38·0
3085	89·8	·990	·1192	·0462	38·8
3136	76·4	·795	·0814	·0311	38·2
3200	90·2	·960	·1160	·0448	38·6
3234	78·0	·803	·0840	·0328	39·1
3722	76·4	·685	·0702	·0291	41·5
3750	91·9	·890	·1100	·0466	42·6
3957	98·8	·940	·1246	·0544	43·7
3992	91·9	·840	·1035	·0454	43·8
4065	90·5	·820	·0995	·0512	51·4
4284	98·8	·875	·1160	·0533	45·9
4310	90·7	·780	·0948	·0426	45·0
4352	98·6	·850	·1124	·0516	45·9
4860	96·6	·750	·0971	·0437	45·0
4910	98·8	·775	·1027	·0490	47·7
4922	100·0	·812	·1094	·0519	47·5
4975	96·4	·720	·0930	·0399	42·9
5050	95·8	·690	·0886	·0376	42·4
5640	96·0	·690	·0888	·0388	43·7
5870	95·8	·660	·0847	·0365	43·1
6100	95·3	·610	·0779	·0299	38·4
6130	95·9	·630	·0810	·0321	39·7
6206	95·5	·620	·0794	·0315	39·7

TABLE III.

NAME OF MOTOR.	Weight in pounds.	Maximum H.P. delivered.	Horse-power per lb. weight.
Griscom	2·8	·0202	·0072
Ayrton and Perry	39·	·1738	·0045
Gramme "à petite lumière"...	172·	1·316	·0077
Magneto Gramme	70·0	·1512	·0022
Thompson	6·3	·0138	·0022
Deprez	9·6	·0138	·0015
Monarch	6·1	·0041	·0007
Cleveland	18·5	·1290	·0032
Model Edison	15·25	·0544	·0036
Diehl, No. 1	9·5	·0209	·0022
Diehl, No. 2	20·0	·0309	·0015
Hill, No. 1.	7·0	·0120	·0017
Hill, No. 2	16·0	·0374	·0023

nearly as high as would be shown with larger machines. Activities varying from 1·31 horse-power to ·004 horse-power have been obtained, with efficiencies varying from 84·5 per cent. to 10·1 per cent. Profs. Ayrton and Perry in their paper on "Electro-Motors and their Government" (*Journal Society of Telegraph Engineers*, 1883), state that motors may be constructed to deliver one horse-power per one hundred pounds of dead weight. Table III. shows the horse-power per pound weight of the various motors tested, and in no case does it rise as high as 0·01 of a horse-power. Their own motor, as will be seen by referring to the table, gives but 0·0045 of a horse-power per pound of dead weight. In the most efficient machine tested, the horse-power delivered per one hundred pounds dead weight of machine falls a little short of 0·8 of a horse-power. I think that for moderately small motors, about three hundred pounds per horse-power would be a closer figure, although with larger motors this would, of course, be considerably reduced.

Rogers Laboratory of Physics,
March, 1887.

Electric Tramways. — Mr. Martin's paper on the comparative statistics of electric railways, which we publish in this issue of the REVIEW, is of great interest. The ratio of electrically-worked lines in America to those in Europe, shows at a glance the rapid strides which electric locomotion is making in the States.

INSULATION OF ELECTRIC LIGHT CONDUCTORS.

DURING the last few years technical journals have discussed, in a fairly exhaustive manner, most of the problems connected with electric lighting, but we do not remember having seen any detailed inquiry into that very important factor—insulation.

From the experience of the last six or seven years and from present practice, one would judge that too little attention has, in general, been paid by electric lighting engineers to insulation, which, beyond doubt, is an element of the greatest importance in the successful and economical carriage of a current from the dynamo-electric machines, or other sources, to the point at which it is to be employed.

No doubt this in a great measure is due to the fact that the current, or as it is often called "quantity of current," is very frequently considered to be largely in excess of what is absolutely required for the particular work, and it is therefore assumed the system can well afford to sustain a considerable loss. That this idea is not altogether uncommon is proved by the circumstance, of almost daily occurrence, that while increasing the size of the conductors, the necessity of also increasing the quantity and quality of insulating material has been to a great extent lost sight of. There is also a feeling that the extra cost entailed in obtaining good insulation, is in a degree so much money thrown away, on the principle that any insulation is good enough for the purpose. To a certain extent this is true, but only with the condition that the material employed, while giving a low insulation, is so mechanically perfect, that it will stand the tests of time and rough usage, a combination of qualities totally absent from most of the materials in general use; and there can be but little doubt that many of the failures in electric lighting installations are due to the want of a proper appreciation of the dangers run by employing poorly insulated wires.

As the electromotive force employed on ordinary underground lines is within certain limits much the same as that made use of in electric lighting generally, there appears to us no reason why the experience gained, during the last thirty-five years, of many forms of insulating substances, should not be taken advantage of by electric lighting engineers, more especially since the mechanical conditions necessary are in both cases almost identical, the exception being that electric light conductors when in use are always at a much higher temperature than is the case with ordinary telegraph wires, and consequently greater care is requisite in the making of the metal joints in the conductor. Indeed, this is a point so frequently overlooked, that many failures can be directly attributed to carelessness in this respect. At the same time it must be remembered that while electric lighting currents are more or less of the same electromotive force as those employed in ordinary telegraphy, they are more dangerous to the life of an insulated wire, inasmuch as the volume of current is greater, and consequently where electrical or mechanical faults appear, the damage done is greatly in excess of that resulting from faults in underground wires as used in ordinary telegraphy. Of course it may be urged that the circuits in electric lighting are of a lower conductor resistance than those in ordinary telegraph lines, and consequently the trial to the leads is less severe, but when the insulation becomes so low as to be almost faulty (not infrequently the case), the fact of the conductor offering a comparatively low resistance will not be of any practical use as a preventive of accidents.

We do not mean to assert that no attention whatever has been paid to the question of insulation, for a glance at the Patent Office records shows us that almost every conceivable substance, vegetable and mineral, has been put into requisition, doubtlessly with the sanguine expectation of a cheap material being at last discovered, combining all the electrical and mechanical qualities

necessary; but we do maintain that the subject has been very much neglected, and that there has been too great a tendency to revert to types abandoned, in ordinary underground telegraphy, many years ago.

Manufacturers cannot be held entirely responsible for this condition of affairs; as a rule, they have merely to carry out specified orders or instructions; indeed, it frequently happens that the manufacturer is not informed as to the work for which his conductors are intended, that is, whether they are meant to be employed as indoor, overhead, or underground lines, nor is he always advised as to the currents they are likely to carry, so he really has no chance of recommending the particular type of lead which, from a large and varied experience, he has ascertained to be best suited for the particular purpose.

The demand for cheaply insulated wires is so great, that many manufacturers, in order to supply the class of goods required, are compelled to employ inferior material, and that frequently not even in a sufficient quantity. No doubt cheapness is a most important element in all installations, but when we hear of heavy currents being carried over wires which have merely a thin coating of cotton or tape impregnated with some so-called non-combustible and insulating solution without any further protection, and of bare wires being laid down in some so-called insulating compound, we are not surprised that installations have broken down, or that damage to property has resulted.

The yearly increasing cost of India-rubber and gutta-percha has had the effect of giving a great stimulus to the manufacture of compositions, endless in number and infinite as to the variety of materials employed. It is not too severe a verdict to condemn the majority of these compounds as valueless. Many of them certainly give a very high insulation directly after manufacture and when first laid down. These tests are, however, pre-eminently fallacious, for the leads have not undergone the vicissitudes which surely await them in their subterranean or overhead life. They have as yet experienced no sudden or severe changes from heat to cold, from wet to dry; they have been subject to no rough handling, to no bending or twisting, to no removal and replacing, to no blows or heavy pressures. These are frequently the conditions, in no way exaggerated, to which electric light leads are exposed, and under which the mechanical qualities of the compositions above referred to are found to be totally inefficient.

Good insulation and mechanical perfectness are not, however, the only points to be considered in the selection of a material. Although electrostatic capacity with regard to its retarding influence upon currents has been frequently referred to in connection with underground electric lighting leads, its effect is generally admitted to be inappreciable, for the reason that the lengths of circuits dealt with in electric light installations are comparatively short. This reason is so sufficient that even in the employment of alternating machines where rapid and successive changes of current take place, the question might almost be summarily dismissed from consideration where ordinary lengths of conductor are dealt with.

The quality which the insulating substance possesses of allowing some portion of the heat generated in the wire to be conducted to the surface and there dissipated into the surrounding air, without prejudicing the insulation, is a most important matter, but unfortunately experiments have as yet been insufficient in providing the data necessary to enable us to speak with any decided opinion on the subject, or if such experiments have been carried out to any practical extent, the results, with one or two exceptions, have not, so far as we can call to mind, been made public. We shall, consequently, limit our remarks to the consideration of insulation and mechanical qualities, and we would here point out that while insisting on the necessity of good insulation, the mechanical attributes of the materials to be employed are of much greater importance.

In America, where electric lighting is far more extensively made use of than in this country, there seems to be a correspondingly greater amount of difficulty with regard to the insulation and preservation of underground wires. This to a great extent would appear to be accounted for by the almost universal employment in the States of certain bituminous compounds and of kerite. Although the manufacture of India-rubber for ordinary purposes is perhaps better understood in America than in England, its employment in the former country for insulating conductors has not made any very great advance. On the other hand, we believe we are correct in stating that the most satisfactory installations in this country are those which have been supplied with well-insulated, rubber-covered conductors.

As an example of the endurance of properly made India-rubber covered leads, we may state (with the permission of the Silvertown Company) that in the works at Silvertown, the system of underground wires serving an installation of 148 arc and over 1,300 incandescence lamps, has been laid down for more than four years, and we are informed that not once during the whole of this period has the slightest repair been necessary. We understand this company's installation comprises more than 12 miles of main conductors, the greater portion being underground. Our attention has also been called to the electric light system of Philadelphia, where the conductors are covered with pure Para rubber. The installation has been at work for more than two years, and, as yet, not a single hitch has occurred, so far as the conductors are concerned.

On looking over some American journals, we find, from a hurried glance through the reports drawn up by commissions appointed by municipal authorities for the purpose of enquiring into the question of overhead *versus* underground wires, and of deciding as to the best mode of insulating and preserving the conductors, there seems to have been a considerable diversity of opinion on the first-mentioned question, the majority, we believe, being in favour of underground conductors. The reports, however, of the commissions as to the best mode of insulating the wires leave us with the impression that all methods in use at present are thoroughly and equally defective. We further read that of the fires in New York directly attributable to electric light conductors, at least 78 per cent. have been traced to underground wires, and of these 80 per cent. are stated to have been caused by low-tension incandescence circuits. Even if these figures are only approximately correct, it is evident that the insulation, and the mechanical efficiency of the materials employed, as we understand these terms, must have been of a deplorably unsatisfactory nature.

We will now proceed to a brief examination of some of the many materials and compositions which have been, or are, employed in the insulation of underground conductors. As our readers can well understand, it is very difficult to get at the truth with respect to results obtained by the employment of any particular material. Criticism, therefore, in the cases where absolute knowledge of success or failure is absent, must be dependent on an acquaintance with the materials used, and on a comparison with the results of their employment for other purposes and in other combinations. This is not such an arbitrary method as might at first appear, for there are sufficiently well-known examples regarding most of the materials and ingredients used to enable us to form a fairly just and unprejudiced opinion as to their respective merits.

We no doubt expose ourselves to being hauled over the coals for giving, in many cases, an unfavourable verdict, but this is a risk we are obliged to run, and we hope that if we have unjustly condemned any particular system, it will be remembered that we write with the express purpose of eliciting the truth.

We do not for a moment pretend to discuss every method made use of in the application, for the purpose of insulation, of the many and various materials and combinations; this would be altogether a too gigantic enterprise. We have sought rather, to investigate the qualities of the principal materials in general use, giving one or two examples of the manner in which they have been employed.

(*To be continued.*)

UNDERGROUND WIRES FOR FAST-SPEED TELEGRAPHY.

ON the 11th February, 1887, a note was published in the ELECTRICAL REVIEW in regard to some experiments then being carried out at Callender's Cable Works, Erith, with the view of constructing an underground telegraph line, capable of being used over long distances, with high-speed instruments.

These experiments have now been completed, and a report of the results obtained may be of interest, especially in view of recent discussions on underground wires. They were carried out at the suggestion of Mr. W. H. Preece, in conjunction with the Postal Telegraph authorities; the tests were verified by Mr. H. R. Kempe, of the Engineering Department, G.P.O., and comparisons were made with lengths of gutta-percha covered wires in iron pipes, kindly placed for this purpose at the disposal of the Callender Cable Company by the Post Office.

The plan adopted was based on recent researches, the results of which were contained in the paper (reproduced in our columns) presented to the Royal Society on February 17th by Mr. Preece, "On the Limiting Distance of Speech by Telephone."

It was shown in this paper that the speed of the current varies inversely with the product of the total resistance and the total capacity of the circuit. From this fact all the experiments made in connection with the projected line take their start.

The intention throughout has been to combat the difficulties of obtaining a high-current speed in both the above directions, viz., by increasing the section of copper in the conductor, and *per contra*, decreasing its resistance, to the greatest degree consistent with the possible practical expenditure on an underground line, and also by reducing the static capacity of the completed line to a point much lower than obtained hitherto.

In the first case, that of reducing the copper resistance, two sizes of wire were tried, viz., ·097 inch, as used on the Nevin Line, having 6 ohms resistance per mile, and ·128 inch (No. 10 legal standard gauge), having 3½ ohms resistance per mile, to compare with No. 18 gauge wire, with 23 ohms per mile, or 16 gauge wire with 13 ohms per mile; the former being the wire in almost universal use for underground work, and the latter being occasionally employed for important circuits.

These larger-sized conductors were insulated so that the static capacity remained nearly constant for each wire, the wall of dielectric being increased *pro tanto* with the enlarged diameter of the conductor. Such a method of manufacture is not practicable except with a dielectric of relatively low initial cost, and for the purpose in question the material used, Callender's bitite, was specially suitable, as a heavy sheathing could be put on the wire at a very small increased expenditure.

The increased value in working speed obtained from the diminished resistance was represented by

697 in the No. 10 L. S. G. wire,
386 „ Nevin size „

100 representing the ordinary No. 18 L.S.G.; whilst the cost of finished insulated wires was approximately in the ratio of

265 for No. 10 gauge,
175 „ Nevin wire,
100 „ No. 18 gauge.

In the second direction, that of reducing the inductive capacity of the finished circuit, a new method of laying was adopted, differing totally from the plan generally used of drawing wires into iron pipes.

An open case or trough, rectangular in form, was made of bitumen concrete. The pieces composing this were 6 feet in length, and all jointed together, *in situ*, into one continuous case. In this "spacing bridges" were placed at every two feet, for the purpose of carrying a tier of insulated wires and maintaining them parallel to each other. These bridges were fixed by molten bitumen being run in round them, and after the insulated wires were in position resting in the hollow arches of these bridges, more molten bitumen was poured in, completely embedding the insulated wires, and surrounding them on all sides. Second, third, and fourth tiers were laid in a similar manner, the whole available space within the case being thus utilised.

Various modifications were made in the positions and treatment of the insulated wires.

In one case, a solid block of twelve was laid in three tiers, the insulated wires touching each other, but the block being surrounded by a clear half inch of solid bitumen on all sides. These were of No. 10 gauge, and on being tested in an iron pipe, they showed a capacity of ·300 microfarad per mile. When laid complete, as described, their static capacity was reduced to ·195 to ·210 microfarad per mile.

In another case, sixteen similar wires were laid, but in addition to having a half inch of bitumen between the wires and the case, they had half an inch of similar material between each insulated wire and its neighbour. The static capacity was reduced to ·131 to ·135 microfarad per mile, as against ·300 microfarad in iron pipes, and about ·200 microfarad when laid as described previously in block.

During the progress of the work, some tests were obtained showing the prejudicial effects of damp on underground work in respect specially to static capacity. Insulated wires laid in a precisely similar manner to the last series, but in wet fog and heavy rain, tested ·170 to ·180 microfarad per mile, and in damp weather, without rain, from ·140 to ·145 microfarad in place of the ·131 to ·135 obtained in dry weather. It was thought that any moisture adhering to the tape with which all the wires were served over the dielectric, would be expelled by the heat of the molten bitumen, but this is shown not to be the case, and the opinion, already held by many is confirmed that tape, no matter how carefully prepared or dressed, must always act to a certain extent in increasing the static capacity. Various materials were tried as a serving, and a reduced inductive capacity was shown as a less absorbent material was used, the best results being obtained with core, simply insulated, and unprotected by any tape or serving. It was found that wires so insulated alone and laid in a block with half an inch of solid bitumen on all sides of the block, tested ·145 microfarad per mile, as against ·210 when laid in similar conditions but served with tape.

Laying in blocks has several advantages over the more elaborate method of placing each wire with its own sheathing of half an inch of bitumen between the outside of each dielectric, the most important being the saving effected in space and in cost. It will probably be found the best plan suitable for use, and the size of conductor which will doubtless be most suitable and economical will be the ·097 inch wire.

The working speed of such a line will compare with the 18 copper covered with gutta-percha to 7½ taped and drawn into iron pipes, thus:—18 to 7½ C.R × I.C. = 23 × ·250 = 5·750; ·097 C.R. × I.C. = 6 × ·150 = ·900 or about six and-a-half times as effective, whilst it is understood that the cost of laying such a line complete would be little in excess of an ordinary 18 gauge trunk line in iron pipes.

A number of experiments were made with the view of dispensing with insulation on the wire, but in every case it was shown that the conductor must first be insulated thoroughly, and that on this completed core the second process of reduction of static capacity must be made.

Bare copper wires were laid in ordinary refined bitumen and bitumen concrete, but the specific insulation was never high enough to obtain reliable tests, and no reading anyway approaching even ·500 microfarad could be obtained.

Wires served with cotton and tape and compounded were also tried with results but little better than in bare copper, thus showing that to obtain the low readings necessary for any improvement in working capacity a conductor will have to be well insulated.

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The bitite insulation used in this case is said to be a vulcanised material whose base is pure bitumen, absolutely refined to purity, and not the ordinary refined bitumen of commerce. It is made to stand a high temperature and is not in any way injured by the molten bitumen run in around it. The total destruction of gutta-percha when subjected to the same treatment rendered it impossible to carry out a series of tests as to the comparative value of this material when so laid.

It appears from the foregoing that considerable progress has been made towards the production of an underground line such as will be suitable for the heavy work of the present day. It is not pretended by the Callender Company that this system is applicable for town work, or for a network of short service wires such as exists in London and other cities, but it is claimed that it is suitable in all respects for main trunk lines to connect large towns, and that by its use means of rapid telegraphy are provided such as can be given by no other system at anything like the same cost.

A FEW COMPARATIVE STATISTICS OF ELECTRIC RAILWAYS.*

By T. COMMERFORD MARTIN.

IT is not now my intention to present a paper on the general subject of electric railways. That I did at a meeting of the Institute held last December, when I was enabled to offer a few statistics on the electric railway as compared with horse, cable and other methods of traction for street cars. I have found since then a great desire generally for information as to the status of electric roads in the United States and Europe. Street railway men, investors and others have wished to know whether such a thing as an electric road was really operating anywhere or not, and if the lines were running, what the cost of construction and operation was. The tables I submit herewith are intended as an answer to those queries. It has been difficult to get at a common basis of estimate and statement. With regard to the European roads, I would say that I have been greatly indebted for the figures to a most admirable and exhaustive paper, read a few weeks ago by Mr. Anthony Reckenzaun before the London Society of Arts. In Europe, as here, various systems of transmitting the current and of connecting up the motor with the car axles and wheels are in use, and, as yet, no determination as to the best method seems to have been reached.

Respecting the figures for this country, I would say that they are necessarily very much in the shape of an estimate as to the number of passengers; though, by allowing each car only 50,000 passengers a year—merely 150 a day—my calculations come out as rather low. The facts may be summed up by saying that in Europe the electric railways are now carrying passengers at the rate of 3,000,000 annually. In America they are carrying at the rate of over 3,500,000, and when the roads now building are finished—to say nothing of the scores for which contracts are being made—the number carried will be at least 7,000,000 annually. When the roads at the places I enumerate in the tabular foot-notes all go into operation, the number will be easily quadrupled. As to cost, I would remark that in every instance yet brought to notice, electricity has spelled economy. I saw recently some authentic and extremely elaborate statistics for 1879 of street railways and their cost in New York and Brooklyn. They were taken from the various official reports. The showing for the total cost of operation per car ranged between $8 and $10 per day at that time. The saving on that with electricity is, according to circumstances, at least 25 to 40 per cent. with heavy traffic.

In the discussion which followed the reading of Mr. Martin's paper, the CHAIRMAN (Mr. Selbourne) said:—This question of electric railways is one which is very full of promise; it is something which it seems to me will immediately develop extensively, and that within the next two years we shall have five times the number of electric railways in operation that are now in opera-

* Read before the American Institute of Electrical Engineers, May 18th, 1887.

ELECTRIC RAILWAYS IN EUROPE, APRIL, 1887.

Place.	Length.	Motors and Motor cars.	No. of Passengers.	Freight.	Total expense of operation.	Car miles run yearly.	System of Conductors.	Prime power.
Lichterfelde-Berlin, 1881	1¼ miles ...	2	100,000 yearly.	...	...	...	All rail.	Steam engine.
Brighton, 1883 ...	1 mile (single track) ...	2	1,000,000 total.	...	1·92d. per car mile.	46,950	All rail.	Gas engine.
Moedling-Hinterbruehl, 1884	2·8 miles (single track and sidings) ...	12	340,000 yearly.	...	3·42d. per car mile.	91,002	Overhead slotted tubes	Steam engine.
Frankfort-Offenbach, 1884 ...	4·1 miles (double track) ...	14	990,000 yearly.	...	3·83d. per car mile.	292,269	Overhead slotted tubes	Steam engine.
Zankerode (mine) 1882	790 yards (double track) ...	1 locom. 16 wagons	...	300 tons daily.	·77d. per ton.	660 wagons daily.	Overhead inverted ⊥ rail	Steam engine
Hohenzollern (mine) 1884 ...	820 yards (double track) ...	1 locom. 15 wagons	...	300 tons daily.	·5d. per ton.	600 wagons daily.	Overhead inverted ⊥ rail	Steam engine.
Portrush, 1883 ...	6 miles (single track) ...	4	Over 100,000 up to 1885.	...	2½d. per car mile.	...	Third rail.	Water power.
Bessbrook, 1885 ...	3 miles (single track) ...	8	300,000 yearly.	30,000 tons yearly.	4d. per train per mile.	60,000 trn. miles daily.	Third rail.	Water power.
Blackpool, 1884 ...	2 miles (single and double)...	10	Over 1,000,000 total.	...	Less than 4d. per car mile.	...	Conduit.	Steam engine.
Brussels, 1887 ...	...	5	...	...	...	...	Operated by storage batteries.	
Hamburg, 1886 ...	...	2	...	...	...	...	Operated by storage batteries.	

NEW ROADS.—A special charter has been granted by the Austrian Government for a road in the Austrian Alps to cost about $350,000, and to be 15 miles in length.

A road is being built in the great salt mines at Stassfurt, Germany.

The North Metropolitan Tramway Company in London has several motors now ready for use with storage batteries on its line, awaiting powers from Parliament.

ELECTRIC RAILWAYS IN AMERICA, MAY, 1887.

Place.	Length.	Motors and motor cars.	No. of passengers.	Freight.	Expense of operation.	Car miles run.	System of conductors.	Prime power.
*Baltimore, Md., 1885	2 miles (single track with turn outs)	6	260,000 yearly	...	$4 per car per day	Each motor runs 73 mi. daily	Third rail and overhead wire	Steam engine
*Los Angeles, Cal. 1887	3 miles, single and double	8	200,000 yearly	...	...	...	Single and double overhead wire	Steam engine
*Port Huron, Mich., 1885–6	4 miles, single track	8	275,000 yearly	...	...	...	Single overhead conductor	Steam engine
*Windsor, Can., 1885	Nearly 2 miles, single track	2	200,000 yearly	...	$4 per day for power	64 miles each car per day	Single overhead conductor	Steam power from electric light station
*Highland Park, Detroit, Mich., 1886	3½ miles, single track	2	200,000 yearly	...	80 cents. per day for fuel	Each runs 13 hours daily; capacity, 30 passengers; speed, 15 miles an hour	Sunken central rail	Steam engine
*Dix Road, Detroit, Mich., 1886	1¾ miles, single track	4	300,000 yearly	...	...	The trains run from 6 a.m. to 11 p.m.	Dble. overhead conductor	Steam engine
*Appleton, Wis., 1886	4½ miles, single track and double	8	400,000 yearly	...	For power, wages of one man as they own their own water power.	17 hours daily	Double overhead wire	Turbine within wheels
*Scranton, Pa., 1886	3¾ miles, single track, four sidings	3	300,000 yearly	...	$9 per day for power, but are putting in their own engine	Each car runs 85 miles per day	Overhead wire	Steam power from electric light station
Denver, Col., 1886	3½ miles, single and double	7	500,000 yearly	...	$1.50 per day for fuel	...	Conduit for series system	Steam engine
Montgomery, Ala. 1885–6	11 miles, single and double	18	This ran 2 cars one year. Have just started other cars. 1,000,000 yrly.	...	50 per cent. less than horse and mule traction — Gen. manager's report	...	Overhead conductor.	Steam engine
†Kansas City, Mo.	...	...	...	...	...	...	...	...
Orange, N.J., 1887	¼ mile built	1	...	...	...	...	Overhead conductor	Steam engine
Boston, Mass. (sugar refinery), 1887	Short track within the works.	1 locomotive, 3 cars	...	The cars in constant use all day; the loads averaging 10 tons per trip, and each round trip averaging 5 minutes	...	...	Overhead conductor	Operated from the lighting dynamo

* Extending line or increasing rolling stock. † No specific details received, line not being yet in regular operation.

NEW ROADS.—Electric railways are now in course of construction, or under contract, at Pittsburgh (3 roads); Los Angeles; Binghamton, N.Y., 4½ miles, 8 motor cars; Lima, O., 3 miles, 6 cars; San Diego, Cal., 9 miles, four 40 H.P. motor cars; Ansonia, Conn., 3½ miles (water power); New York city (for Fulton Street), St. Joseph, Mo., 20 cars; Mansfield, O.; Ithaca, N. Y.; Harrisburg, Pa.; Woonsocket, R. I.; Richmond, Va., 40 cars, 11 miles of track,

Companies have been formed or steps taken to build and operate electric roads at Flushing, L. I. (2); Lincoln, Neb.; Brookline, Mass. (2); East Cambridge, Mass.; Newton, Mass.; Boston, Mass.; Asbury Park, N. J.; Pelham Park, N. Y.; New Brunswick, N. J.; Plainfield, N. J.; Bayonne, N. J.; Worcester, Mass.; Scranton, Pa.; Carbondale, Pa.; Philadelphia, Pa.; Reading, Pa.; Bangor, Me.; Biddeford, Me.; Westfield, Mass.; Chicopee, Mass.; Muncie, Ind.; Gratiot, Mich.; Tiffin, O.; Cincinnati, O.; Brooklyn, N. Y.; Coney Island, N. Y.; Rockaway, N. Y.; Winston, N. C.; Jacksonville, Fla.; Pensacola, Fla.; Birmingham, Ala.; Selma, Ala.; Atlanta, Ga.; Fort Smith, Ark.; Wichita, Kan.; San Francisco; San Jose, Cal.; Newton, Kan.

tion. This morning, Mr. Frank L. Pope, our worthy past president, made some statements in regard to investigations which he had made with reference to that subject, and I at that time felt on the point of asking, as he did not state the location of the proposed railway, nor what storage battery he had calculated upon, whether in his calculations he took as the basis the storage battery that he had investigated, that is the Julien battery, as I understand, and whether he made any estimate as to the comparative percentage of cost for running a car per mile hour with such a battery as compared with horse-power.

MR. FRANK L. POPE: I did not specify the kind of battery used nor the railway that we were making tests for, simply because I did not wish to be regarded as having advertising purposes in view, but I have no objection to giving the information. The investigations were undertaken for the West End Street Railroad Company, of Boston, and the battery, of which we have completed a test, is the Julien battery. I may add that we have devoted much attention to getting, as nearly as we can, in the absence of actual experiment on the road under working conditions, at the probable comparative cost of power of different methods of running, and I think it will come out about 7 cents per car mile by accumulators, as against 10 to 11 cents per car mile by horse-power. Experience may modify these figures; but I do not imagine they will be far from the true cost. We have spared no pains or expense to get accurate data on all the points involved. The management of the West End Company have shown a most commendable spirit of liberality throughout.

Telegraph Clerks and Jubilee Day. — Telegraph clerks are protesting against the observance of Jubilee day as a Bank Holiday, which would give no relief, but rather an increase of work, to the vast majority of the telegraph staff, and contend that it should be proclaimed a national holiday, and be observed in the Post Office as a Sunday or Christmas day.

THE AMERICAN EXHIBITION.

As a representative display of the "arts, inventions, manufactures, products, and resources of the United States," the exhibition now being held at Earl's Court can hardly be considered a very brilliant success, though as a place of amusement it may be admitted to possess some attractions, foremost of which is, of course, the gigantic circus performance of Buffalo Bill's company of riders and sharpshooters from the Far West. The electric lighting of the buildings and grounds, which is on the Thomson-Houston system, is remarkably good, the lights being "as usual" steady and easily managed. The installation was put up in a remarkably short time, and the public lighting had to be started without any preliminary regulating and testing. The management appears to have arranged with Messrs. Laing, Wharton and Down to carry out the lighting, and with Messrs. Hornsby and Son to supply the requisite steam power. Where the lighting, as in this case, is not divided amongst several firms, but wholly entrusted to one, an arrangement of this sort seems to amount to an unnecessary tying of the hands of the contractors, who must be the best judges of their own requirements, and ought, one would suppose, to be at liberty to make their own choice of the steam engines to be employed for driving their machinery. However, the Thomson-Houston system is, perhaps, as little dependent as any upon perfectly steady running, and in actual experience a variation of as much as 30 per cent. in the speed of the engine has been found to have no effect upon the steadiness of the lamps. Throughout the main building and grounds there are nearly 300 arc lamps, each of 2,000 C.P., some of which are of the type already familiar, while others are of a newly-introduced form, with the regulating mechanism enclosed in a tubular top, similar in appearance to a Brush lamp. The generating plant consists of ten dynamos, specially made for the purpose, which, though similar to the 30 and 40-lighters used at South Kensington, are, as a result of improvements in winding and construction, capable of giving an output of 35 and 50 lights respectively. The wiring is on an American system, what is known in the States as "Underwriters' wire" being employed. The merits of the insulation of this wire has been the subject of considerable discussion lately, and some unfavourable opinions have been published, but Messrs. Laing, Wharton and Down have nothing but unqualified praise to give it, contending that in practice the insulation, which is good at first, improves as time goes on, exposure to the weather having upon it nothing but a beneficial effect. Our readers will, however, probably consider this statement open to serious doubt. The arena for the Wild West performance is specially illuminated by Brush lamps of 10,000 candle-power, the central one being a search light, which is directed as required upon the performers. These lamps are operated by the Anglo-American Brush Corporation, which has its own dynamos, engine, and engine house for the purpose.

The motive power for the whole of the electric lighting at this exhibition, amounting to 600 H.P., is supplied by Messrs. Richard Hornsby and Sons, Limited, of Grantham, whose compound engines have been successfully employed for some important electric light installations, both at home and abroad. The following particulars of the engine and boilers will probably prove of interest to our readers.

There are three *compound engines "underneath"* of 50, 30, and 10 nominal horse-power respectively, the engines being arranged underneath the boilers. The following are some of the special points in this class of engines. The cylinders are well steam-jacketted, the jackets are drained by an automatic steam trap. The crank-shaft is supported by a massive cast iron frame, bolted in between the wrought iron frame, thus preventing entirely the vibration to which a wrought iron frame is so subject. The boiler is of steel, constructed for a working pressure of 140 lbs. to the square inch, all the plates are flanged and rivetted by hydraulic machinery and annealed, thus avoiding the dangerous strains set up by local heating in working.

There is also a pair of *coupled compound horizontal engines* on massive cast iron base plates; high pressure cylinder 16 inches diameter, low pressure cylinder 28 inches diameter, both of 2 feet 6 inches stroke, running at a speed of 80 revolutions per minute, the power being taken off a turned fly-wheel 12 feet diameter and 2 feet wide on the face. The cylinders and steam chests are well jacketted, and the high pressure cylinder is provided with a blow-through valve to enable the engine to be easily started. The receiver between the two cylinders, besides being well lagged, is provided with an efficient means of superheating steam. The reciprocating parts have been well balanced, with the object of ensuring steadiness of running. Special attention has been paid to the lubricating of the engines, sight-feed lubricators being fitted to the cylinders, and similar ones at the crank-shaft end of the bed plates for lubricating the crank pins by means of a tube returned from the centre of the crank pin to the centre of the shaft, and terminating in a cup into which the oil drops from the lubricator, and is fed by centrifugal force into the bearing. The engines are well finished, all joints are case hardened, and the crank-shaft, piston rods, valve spindle rods, and all pins are of steel. Extra large bearing surfaces are given throughout to enable these engines to work continuously.

In addition there is a pair of *coupled horizontal engines* of a similar type to the compound engines just described, with cylinders 13 inches diameter and with 14 inches stroke, the power being taken off a turned fly-wheel 9 feet diameter 20 inches wide on the face. As in the compound engines, the piston rods, valve spindles, crank-shaft, and pins are all of steel.

Hornsby's automatic expansion gear, which is fitted to each of the foregoing engines, is now well known. It is a simple arrangement whereby an expansion cut-off valve on the back of the main slide valve is worked by an eccentric and vibrating link, the movement or travel being controlled by the governor raising or lowering a die in the link, and in order to prevent the jumping or jerking action usual in such gears, the die is worked from an eccentric ring of considerable diameter, the sheaves of this eccentric being so coupled to the governor as to make a partial revolution as the balls rise or fall and so raise or lower the die. The basis of this arrangement is that the eccentric makes a good driver, and being arranged on the spindle which takes its motion from the governor, all action tending to disturb the governor is by its use effectually absorbed.

An *overhead vertical engine* is also employed with cylinder 7 inches diameter and 9 inches stroke, supported by a massive cast iron pillar of box section which with the crank-shaft bearings and bed plate is all in one casting. The cylinder and valve chest are well jacketted, and as these engines are intended to run at the high speed of 400 revolutions per minute, the pipes and ports are unusually large and all the reciprocating parts well balanced. The piston rod is of steel and the cross head works in a slipper slide, the connecting rod is of the marine type and the crank-shaft of steel. All the bearings are of very large proportions, and the same attention has been paid to the lubricating as in the engines previously described. The speed is controlled by a new spring governor running at a high speed, and which though remarkably simple, is very efficient. This class of engines has been specially designed for electrical engineering work on board ship, and being of a very compact type should prove successful.

Four *locomotive multitubular boilers* supply the steam for working the horizontal and vertical engines, these boilers being constructed to work at a pressure of 140 lbs. to the square inch. The shells are made of mild steel with fire boxes of Lowmoor iron, the longitudinal seams are double rivetted, and are amply provided with stays to resist the pressure. The water supply, we notice, is very complete, each boiler being provided with a donkey pump and injector.

All the belts for driving the dynamos have been supplied by the Gasking Patent Driving Belt and Leather Company, Limited. The belting made by this company is a combination of a chain of metal links (generally of steel) with a chain of leather links.

In some cases the leathers are arranged in solid pads between rows of metal links; in other cases the leathers are divided, and the metal links interspersed amongst them and divided by the leather, so that no two metal links work against each other. The strain upon the pins is also more equally divided by the latter arrangement. This combination secures very great power of "grip" and "durability," in addition to which the belt has extraordinary tensile strength and suppleness, and runs with the greatest possible steadiness and regularity; it is also jointless when coupled up. As compared with good double leather belting, it is calculated to cost less, owing to the fact that link bands at least 20 per cent. less in width are required to do the same work.

THE RELATION BETWEEN THE CROSS SECTION OF THE IRON IN ARMATURE AND FIELD OF THE GRAMME DYNAMO.*

By MR. DUGALD JACKSON.

THE relation between the cross section of iron in the armature core to that in the magnet limbs in a dynamo machine is an important one. On its proper adjustment, in an otherwise well-designed machine, depends the attainment of maximum efficient output per pound of wire with minimum of iron. Of two machines designed for a given purpose, the one with a Siemens armature and the other with a Gramme ring, the path of the lines of force through the armature of the latter machine will usually be considerably longer than in that of the other. It is evident that special care should be exercised to make the Gramme armature of sufficient area of cross section that its magnetic resistance be not increased unduly. Siemens armatures from mechanical principles call for a goodly amount of iron, while an increase of cross section in a Gramme armature increases mechanical difficulties considerably. Consequently Gramme armatures usually have considerably smaller cross section than Siemens armatures in machines intended for a similar use, magnetic conductivity being sacrificed for mechanical convenience in the Gramme. How far this sacrifice may be carried without impairing the value of the machine must of necessity be specially determined for each individual case.

The question of how far the characteristic, and so the output of a machine, is influenced by variations in the cross section of the armature could be determined by Hopkinson's very beautiful method of pre-determining characteristics. In a machine, the outline and dimensions of which are determined by conditions imposed, the curves of magnetisation, such as Dr Hopkinson used, would be fixed for the field and air space. By plotting curves for armatures of various cross-section, the area giving the best characteristic, and yet not unduly decreasing the internal diameter of the ring, would be evident. The value of the leakage ratio, v, might be estimated by Prof. George Forbes's method, if the shape of the diagrams were not too complicated.

An experimental solution of the problem for a little dynamo was made this term in the Physical Laboratory at Cornell University. If we had armatures for one dynamo made with cores of various cross sections, the best section would be apparent from the characteristics. However, it is not necessary to wind the armatures, but simply to measure the number of lines of force passing through the armature for various magnetising forces—that is, observing the data for a curve of magnetisation. This may be done in several ways.

In the experiment referred to, a single turn of wire was placed around the section of the armature core perpendicular to the direction of the lines of force. This was connected with a ballistic galvanometer. The swing of the needle of the galvanometer was observed when the current was reversed in the magnetising coils on the field. The swing was thus proportional to $2\,H\,A$; A being the area of the turn of wire, and H the induction per unit area. Knowing the magnetising current and the corresponding swing for a number of points for each of several different armatures, the corresponding curve of magnetisation may be plotted. These curves are exactly similar to the total characteristic of a series dynamo or the internal characteristic of a shunt machine.

The field of the little dynamo experimented upon is of the single horse-shoe type standing upon the yoke. This is rectangular in cross section. The limbs are cylindrical and are held in place on the yoke with two pins each, the contact surfaces being perfectly plane. The yoke and limbs are of the best Norway iron. The pole pieces are of a very good quality of cast iron, and are chambered to fit the upper ends of the limbs, which enter for a length of 7 cm., making the area of contact considerably greater than the cross section of the limbs. The cross section of the pole pieces is much greater than that of the limbs. The bore of the pole pieces is 10·8 cm. in diameter, there being a gap at the top and bottom subtending an angle at the centre of the bore of 51 degrees. The width of the surfaces on either side of the gap is ·3 cm. The corners of the pole pieces are all rounded off.

Following are the dimensions:

Limbs (cylindrical).	
Length	20·3 cm.
Diameter	6·35 ,,
Area of cross section	31·66 sq. cm.
Distance apart from centre to centre	17·9 cm.
Yoke (rectangular).	
Length	26·8 cm.
Width	8·2 ,,
Depth	6·9 ,,
Area of cross section	56·6 sq. cm.
Pole pieces.	
Height	10·2 cm.
Width	10·2 ,,
Bore	10·8 ,,
Mean area of cross section	—— sq. cm.

The magnetising coils consist of 785 turns on each limb, making a total of 1,570 turns.

The armatures were composed of thin punched discs of soft wrought iron obtained through the courtesy of Thos. Pray, jun., of Hartford, Conn. The discs were insulated by dipping them into shellac varnish and then built into armatures by placing them on wooden mandrels turned to fit their internal diameter. The variation in the cross section of the armatures was obtained chiefly by using armatures of the same number of discs, but of different internal diameters. As it was not possible to secure discs with the proper internal diameters to give all the area desired, some of the armatures were composed of fewer discs. In these, thin spaces were left between the discs, and the area enclosed by the exploring coil was slightly greater than that of the iron. The effect of this has been neglected as too small to be appreciable. The areas were obtained by multiplying the thickness of the discs, which was ·0462 cm., by the number on the armature.

The magnetising current was furnished by a number of storage cells. In the circuit of these were placed a tangent galvanometer and the magnetising coils. A reversing key was so placed in the circuit as to simultaneously reverse the current in the galvanometer and coils. The magnetic induction was measured by a ballistic galvanometer, as already explained. The observations were taken by Mr. F. R. Jones, an engineering student working in the laboratory. The regularity of the curves attest the care with which he carried out the work. I have here a sketch, fig. 1, of the curves determined by Mr. Jones, which, I think you will agree with me, are very interesting.

The following table gives the areas of the cross section of the armatures and their ratios to the cross section of the magnet limbs:—

Armature	No.	1	17·75 cm.	...	Ratio	...	0·561
,,	,,	2	19·23 ,,	...	,,	...	0·607
,,	,,	3	20·70 ,,	...	,,	...	0·654
,,	,,	4	22·19 ,,	...	,,	...	0·701
,,	,,	5	23·66 ,,	...	,,	...	0·747
,,	,,	6	25·14 ,,	...	,,	...	0·794
,,	,,	7	27·36 ,,	...	,,	...	0·864
,,	,,	8	29·18 ,,	...	,,	...	0·922
,,	,,	9	34·49 ,,	...	,,	...	1·09
,,	,,	10	42·44 ,,	...	,,	...	1·34

In curve No. 1, where the armature has little more than half the area of the limb, the turn in the characteristic is sharp and the straight line representing the upper portion of the curve is almost horizontal. The rapid and great increase of magnetic resistance shown by the curve to the right of the line, M, must be due entirely to the saturation of the armature. As the area of the armature increases, the turn in the corresponding characteristics grows into a longer sweep, and the upper part of the curve takes an increasing angle with the horizontal. Curves Nos. 9 and 10 are given by armatures greater in cross section than the limb, and though there is a difference in their areas equal to a quarter of the area of the limbs, there is very little difference in the total induction passing through the armature. The curve No. 10 then probably very nearly represents the curve of magnetisation of the iron in the field and the air space. The straight line, which constitutes the lower part of the characteristic, being the backbone of the curve, as it were, must very nearly represent the line of magnetic resistance of the air space. By air space I mean the space between the pole piece and armature.

Looking at the curves there, you see the armature No. 1 was highly saturated, or, in other words, had become of enormous magnetic resistance before the permeability of the field began to decrease appreciably. On the other hand, armature No. 9 has increased in magnetic resistance very little up to the point to which the characteristic has been carried, while the field is quite saturated. Between these extremes there are varying degrees of relative saturation of the armature. In curve No. 7, the field and armature are apparently at about equal degrees of saturation throughout. The curve (shown in fig. 2) illustrates the effect

* Read at the annual meeting of the American Institute of Electrical Engineers, May 18th, 1887.

on the total induction through the armature of the ratio of the area of the armature to that of the limbs. As ordinates are plotted the total induction through the armatures taken from the characteristics on the section line, M. The abscissæ are ratios of the cross section of the armature to that of the limbs.

This curve is exaggerated in vertical scale so that its character may be more plainly seen. It shows obviously that the induction through the armature increased quite rapidly when the armature core was increased in area from ·5 of that of the magnet limbs to about ·75 that of the limbs. From ·75 to ·9 there is still an increase of induction with increase of armature core, though not so good as before, and beyond ·9 the increase is of no practical importance.

If the section at M, fig. 1, had been taken farther up the curves, the relative increase of total induction with increase in the area of the larger armature would not have been so marked.

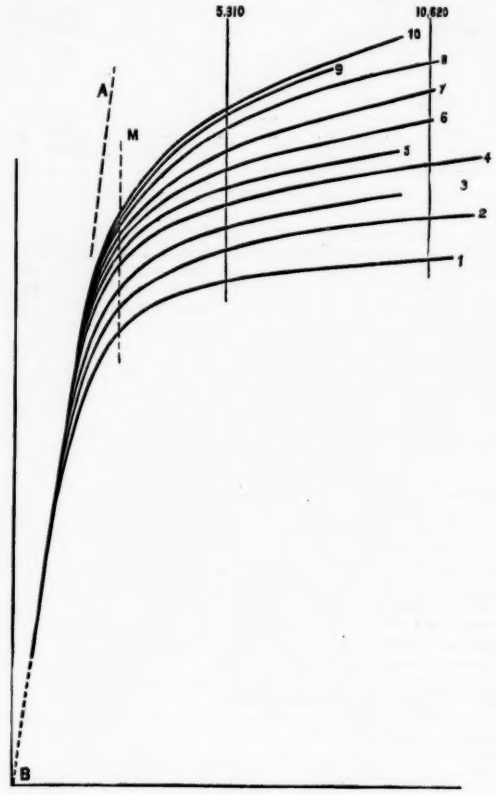


FIG. 1.

The section at M is taken at 2,660 ampère turns; that is, an absolute magnetising force of 33·420. The absolute total inductions for this magneto-motive force as shown in the curve, fig. 2. These were determined by comparing the throw of the ballistic galvanometer given by the armature with that given by a standard coil turned through 180 degrees in the horizontal component of the earth's field. The value of the horizontal component at the place of the standard coil was determined by comparison with that in our magnetic observatory by the use of the compensated magnetometer.

We may safely assume that the cross section of the armature should be about ·75 of the cross section of the limbs if the wire on the armature is to have the greatest activity without an excessive quantity of iron in the core. By making the cross section of the armature ·6 of that of the limbs, a loss of 10 per cent. of the total induction, when the ratio is ·75, would be made, and consequently an equal loss in E.M.F. and the output of the machine. This is a case where the permeability of the field magnet is equal, or very nearly equal, to that of the armature. If the permeability of the armature core were greater than that of the field, the area of armature could be a smaller ratio.

No allowance has been made in this for the effect of a current in the armature. That should, at any rate, be small, except in the case of arc lighting machines, where a great number of turns of wire are placed on the armature with the purpose of gaining stability in the lights.

The absolute intensity of the magnetic flow per square cm. in the armature was quite high. In armature No. 5, the section of which is practically ·75 that of the limbs, an induction of 14,000 per square cm. was given by 2,666 ampère turns. For about 10,000 ampère turns the induction was 17,000 per square cm. 10,000 ampère turns gave an induction of 11,000 per square cm. through armature No. 10 and about 18,000 in armature No. 1. The latter was increased to nearly 19,000 by 12,500 ampère turns.

The induction per square cm. corresponding to the best conditions in this machine is 14,000 per square cm. This is high for a dynamo. I believe Dr. Hopkinson has placed the figure in the Edison-Hopkinson machine as 8,000, and if true, this is probably seldom exceeded. I am aware that the value apparently reached 20,000 in the Manchester dynamo in Hopkinson's late tests, but that high value can not be given much weight, even though the armature was pretty well saturated. I may be placing the limit entirely too low, as I have a number of records where from 10,000 to 15,000 is claimed, but simple claims are endowed with great uncertainty.

It may be interesting to note the ratio of the areas in two or three dynamos of ordinary size. It is impossible to estimate the area of iron in an armature with wire on it, because of the uncertainty in the space occupied by insulating material between the iron discs. In the record of their late tests the Hopkinsons have given the areas of the armature and magnet limbs in the Edison-Hopkinson and the Manchester dynamos. In the Edison-Hopkinson machine the field had probably nearly the same permeability as that of the armature core. The cross section of the armature was about ·8 that of the field, and the field was considerably more saturated than the armature. In the Manchester dynamo the field probably had a lower permeability than the armature, and they were about equally saturated. The cross section of the Gramme ring in this machine was about ·6 that of the cross section of the field.

Professor THOMSON: The subject of dynamo designing is undoubtedly one of very great importance, and I have some few remarks to offer thereon, as I have designed a large number of types of dynamos, and experimented with a considerably greater number. I think that the first thing we should settle in dealing with this subject is the type. What is the machine to do? If you are to run arc lights, your design must be entirely distinct and different from that which you use in running incandescent lights. The reason of that may not at first be so obvious, but if we consider the nature of an arc light we will see it. An

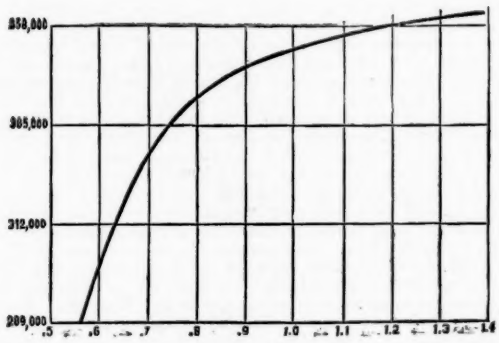


FIG. 2.

electric arc may be running steadily—I speak now, of course, of the long, quiet arc, what may be called the perfectly-developed arc, not a hissing arc (that is a semi-incandescent light, and partakes somewhat of the nature of an incandescent load for the machine)—but a long, well-developed arc with the crater fully exposed, burning quietly, possesses peculiar properties. If it is at a certain condition, 10 ampères and 45 volts, and you increase the current slightly, you may convert that arc into a hissing arc abruptly with a great fall in its resistance. Now what will be the effect, if you have a machine that is worked at its normal current, on the curve of that machine? You will find that the machine is not stable. The current will not stop at 10 ampères if at this point; the current of the field magnets is represented at 10 ampères in a series dynamo; the current will continue rising until a point is reached on the curve where the electromotive force of the machine either drops, or does not increase by the addition of current in its field magnet or exciting circuit. The consequence is that the successful arc lighting machines depart entirely from such terms as you find here. They go up to a certain point when the normal current is reached. There on the bend a little beyond it the line dips, showing that an increased current drops the electromotive force, and that is the condition of stability in running arc lights. The arc may be burning quietly. That will represent the wide, open arc (illustrating)—and this set of actions begins. You design your machine, we will say, with a large amount of iron in your armature and a large amount in your field; you save all the copper you can; you make what may be called a very excellent type of an efficient machine, and then you put on a circuit of arc lamps. You have calculated the excitation, &c. You expect to work the arc lights steadily. You find on closing the circuit that the carbons go apart; a tremendous roar of current comes through, the arcs draw wide open; suddenly the machine ceases to develop current—down come the carbons, and the same operation is repeated continuously. The reason of that is that you have adjusted your arc lamps to run on 10 ampères while your machine is not adjusted to furnish 10 ampères, and be stable under those conditions. The current is not stable until the field magnets have reached a certain degree of saturation—unless your arc lamp mechanism is extremely sensitive. Even in those

conditions—I speak, of course, of the series machines—while the current in the field continues to increase it causes a fall of resistance in the arc, a further increase of current accompanied by a further increase of electromotive force of these currents and to such an extent that, quickly as the arc lamp mechanism can act, it cannot get ahead of the increase of current. It is always behind time in drawing the arcs. It does not act instantaneously, while its effect on the current are always "headed off." Finally there is a rupture of the whole circuit, down come the carbons, and we start again. That is a phenomenon we have met with frequently, and it comes always with an increased amount of iron beyond a certain proportion in the machine. We call it "oscillating," "surging," or "building up" and "dropping down"—rough terms that we have used for the purpose of indicating the condition. It may be interesting to remark in this connection that we tried at one time compounding the machine and endeavouring to work it with a large amount of iron way below saturation, using a derived circuit winding to drop the curve at the proper point. Even in that case there was the same difficulty of surging or oscillation. Now, when we come to the design and construction of dynamos for incandescent lighting or for motive power purposes—the electric motor—then we have, of course, an entirely different state of conditions. Our resistance on the external circuit is not subject to this sudden drop of resistance, but it demands more and more electromotive force to increase the current through it, and we have a dead resistance somewhat similar to this in use on a wire resistance. In that case you can work anywhere you please. On this line (indicating) you can work at about this point: and it may be that an explanation of some of the results Mr. Jackson has pointed out would be found in the fact that most dynamo builders prefer to work pretty low down on the curve. They do not like to buy their magnetism dearly. They would rather put in quantities of iron and diminish the copper in the field magnets, and get their magnetism at a rather low degree of saturation, and you will notice at this point that there is not a very great difference. If you keep working below this point, your differences begin to accumulate as you get up on that curve, so that if you are working at this point, the difference is very large in the amount of iron: if you are working it here (indicating) the differences become less and less. But in motor work, we find by actual practice that we get very good results in constructing motors by putting in a rather larger amount of iron than has been customary in the armature. We have made the permeability of the armature very much lower than the ordinary practice of dynamo design has called for, and it is a question whether the movement in the direction of increasing the mechanical conductivity of the armature iron is not, even with dynamos, a proper step. The limitation of increasing the iron sections will be found in that plan between two conditions working against us, and the condition of increased output, as shown by these curves, working for us; that is, if we use the armature iron in larger sections, we may make it so that the changes of current increase the heat; that is, the Foucault currents may trouble us. And if we make it of larger section also, we increase the length of wire which is to go around it—one turn of wire required to cover the increased section—and those influences may be said to be working against us, so that there will be a point somewhere on this curve at which we will find the maximum conditions. In motor work, our design, of course, is to pass as much as possible of the magnetism we develop through the armature, and the armature itself assists us in doing that. There seems to be no reason why we should not use a comparatively large section of armature iron in a motor. We develop a field magnetism which we do not wish conducted out into the air, and therefore we give it the best path possible through the armature. The motor would seem to be made of the best possible design when we have given a very ample section in the armature for the passage of the lines of force.

Mr. MAILLOUX: I would like to ask Mr. Jackson whether his statement is, that seventy-five per cent. sectional area is what he considers the best proportion. In my practice, whenever I have used the Gramme ring I have always used a sectional area at least equal to the sectional area of the limb. I did that, not because I apprehended that I needed such a large amount, but because I realised that only a portion of that sectional area can be utilised—employed usefully in conveying lines of force. Some years ago I discussed that question through the Press, and called attention to what struck me then as a new way of looking at the subject, and it is this: that as the lines of force make the ring their path in passing from one pole to another, it is quite evident that the tendency for lines of force is, like other things in nature, to take the path of least resistance, the shortest path, and, consequently, to crowd each other. Now, it is quite plain to my mind that there must be a condition of lines of force on the periphery of the ring, on the outer surface, different from what there is inside, and, consequently, this must mean an increased resistance of penetration. In other words, the coefficient of permeability must become lower, no matter what the resistance of the iron is, at the point where the lines of force enter into the core, as well as where they emerge from it; so that we might have a core of very great section, and if the magnetic density, so to speak, is very great on the outer surface, then the resistance to further penetration will be so far reduced that only a portion of the sectional area will be useful in conveying lines of force. I was led to look at this from the fact that a great many builders of Gramme rings have departed from the old method of constructing the core of fine wire wound into a solid annulus, and instead have used laminated rings of more or less thickness and separated from each other at a certain distance. Now I have noticed that although they get much less weight of metal in a given area of section in an armature than would be the case if they used fine wire, yet they seem to obtain very nearly as good results. And it has always been a question in my mind whether the use of laminated rings, leaving a space between, did not afford better opportunities for the lines of force to seek new paths—to enter by the side of each lamina—instead of being forced to enter at the periphery. I know that there is a great deal of diversity of opinion amongst physicists as to the possibility of a piece of iron being saturated at one part and not magnetised at another part. I remember at the National Electrical Conference in Philadelphia, in 1884, the statement made by Prof. Silvanus P. Thompson was harshly criticised, when he said that the central part of a core might not be magnetised though the inside might be saturated. I do not know on which side of the question to stand, but I am willing to be educated on that subject. I have been told by a maker of dynamos that taking poles of very large sectional area he could take out the central part of it without interfering at all with the nature of the characteristic curves. Those are significant points, and some information on them would be very acceptable.

THE MEASUREMENT OF SELF-INDUCTION, MUTUAL INDUCTION AND CAPACITY.*

By W. E. SUMPNER, B.Sc.

(*Continued from page* 550.)

Fig. 1 represents Maxwell's method of comparing two self-inductions, but we may regard the self-induction in the branch, q, as removed, provided we suppose that of the branch, s, to be

$$L_s - \frac{r}{p} L_q.$$

Fig. 2 represents Maxwell's method of comparing two mutual inductions. Fig. 11 represents the same method when the current runs through the bridge. For mere comparison it is better to use

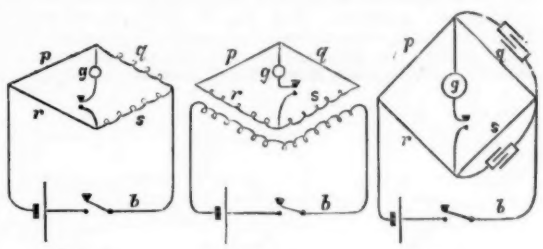


FIG. 1. FIG. 2. FIG. 3.

the arrangement of fig. 2. For absolute measurement it is better to use the arrangement of fig. 11. In the latter case we may regard the effective self-induction of the branch, p, as being

$$\frac{s+q}{s} M_{pb} \pm \frac{r+p}{s} M_{qb},$$

and we may regard the mutual induction as being altogether removed.

Fig. 3 represents a method of comparing two capacities. We may regard the branch, s, as having an effective self-induction of

$$\frac{r}{p} \cdot q^2 K_q - s^2 K_s.$$

Fig, 4 represents a method of comparing mutual induction with capacity. We may regard the effective self-induction of the branch, r, as being

$$\pm \frac{s+q}{q} M_{rb} - q\, r\, K_q.$$

Fig. 5 represents Maxwell's method of comparing self-induction with capacity. We may regard the effective self-induction of the branch, r, as being

$$L_r - q\, r\, K_q.$$

Fig. 6 represents Maxwell's method of comparing self-induction with mutual induction. The effective self-induction of the branch, s, is

$$L_s \pm \frac{p+r}{p} M_{sb}.$$

* Read in the discussion which followed the reading of Professors Ayrton and Perry's paper on "Modes of Measuring the Coefficients of Mutual and Self-Induction," before the Society of Telegraph-Engineers and Electricians, May 12th, 1887.

Figs. 7, 8, 9 represent analogous methods of finding self-induction, mutual induction, and capacity. The effective self-induction of the branch, s, is L_s for fig. 7, $\frac{p+r}{p} M_{sb}$ for fig. 8, and $-s^2 K_s$ for fig. 9.

Fig. 10 is an illustration of the combination of the above methods. The effective self-induction of the branch, s, in this case is

$$L_s - p\,s\,K_p \pm \frac{s+q}{q} \cdot \frac{q}{p} M_{rb} - \frac{q}{p} L_r.$$

The interest of the above methods consists in the fact that they are methods to measure absolutely the difference between two quantities. The most accurate way of measuring the ratio of two resistances is well known to be that of Professor Carey Foster, who measures the difference between two nearly equal resistances in terms of the resistance of an observed length of a uniform wire; and by that means, if either of the resistances is known fairly accurately, their ratio can be determined with extreme accuracy. The above methods are analogous with that of Professor Carey Foster.

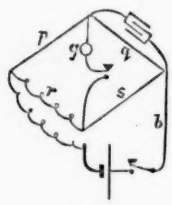


FIG. 4.

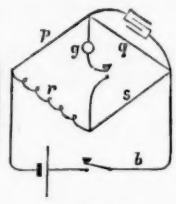


FIG. 5.

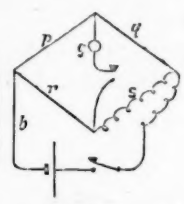


FIG. 6.

When, however, we employ the cumulative method exemplified in the secohmmeter of Professors Ayrton and Perry, the analogy is still more complete. In using a wire bridge it is very difficult to determine the exact position of the slider, although it is very easy to determine accurately the difference between two of its positions; and the great accuracy of Professor Foster's method is due to the fact that it is not necessary to determine the absolute position of the slider, because all that is required is the difference between two positions. Now one of the faults of Maxwell's methods consists in the necessity of having a very exact balance of the bridge. As an example, when the branches r and s were each about 6,000 ohms, it was found necessary to adjust r to a

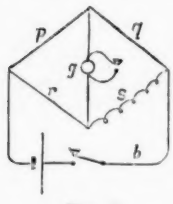


FIG. 7.

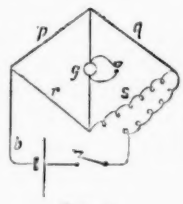


FIG. 8.

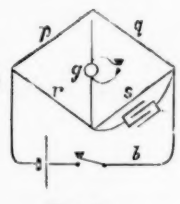


FIG. 9.

small fraction of an ohm by adjusting the length of a bare wire connecting two terminals, and even then the heating caused by keeping on the battery for a moment so altered the balance that a correction had to be applied. However, when the cumulative method of Professors Ayrton and Perry is employed, it is not necessary to have the bridge balanced at all. It is only necessary to have the bridge so nearly balanced that the spot may be on the scale.

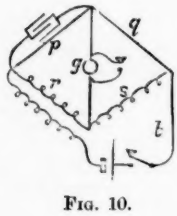


FIG. 10.

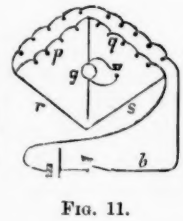


FIG. 11.

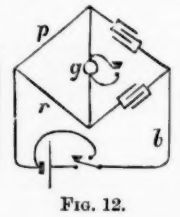


FIG. 12.

This result is a simple deduction from equation (13) of the paper of Professors Ayrton and Perry. It may also be proved as follows:—

If there is no induction in the bridge, but the arm, s, is deranged from balance by an amount σ_0, the deflection D_0 of the galvanometer will be proportional to σ_0 for small derangements; so that

$$D_0 = k\,\sigma_0,$$

k being a constant. If the battery is on for only a portion (l) of the time, the deflection, D'_0 will be l times this; so that

$$D'_0 = (l\,D_0) = l\,k\,\sigma_0;$$

and if we increase the resistances of the branches, r and s, by small amounts proportional to r and s the deflection will not be altered. Now in testing for self-induction we practically increase the resistance of the arm, s, by an amount, σ, in consequence of the self-induction, and in order to find out what is the value of σ we increase the arm, r, by an amount, which bears the same proportion to p that σ does to q. We shall know this is the case when the deflection of the galvanometer is $l\,D_0$, where l is the lead of the secohmmeter—*i.e.*, the proportion of the time the galvanometer and battery are on together to the period of the commutator.

So that in testing with the secohmmeter,

(1) Observe the position of rest (z) of the spot.

(2) Adjust the bridge roughly for resistance until the spot comes to a point, D_0, not far from z.

(3) Take a point on the scale between these two, such that its distance from z bears to the distance between z and D_0 the proportion of the lead of the instrument, and use this point as a zero.

(4) Derange the bridge by a known amount, and turn the secohmmeter till the spot of light passes slowly through the zero. At this moment press the key and take the speed reading.

By this method only one error of judgment can arise, viz., the determination of the speed.

The analogy with the method of Professor Foster is clearly shown by the fact that the same wire bridge can be used. If in fig. 7 the resistance $p + q$ be that of a straight uniform wire, we have—

1. For resistance balance—

$$s : r = q : p,$$

or

$$s : r + s = q : q + p.$$

2. For commutative balance—

$$s + \sigma : r + s + \sigma = q' : q' + p',$$

where σ is the effective increase of resistance owing to self-induction.

$$\sigma = \frac{n\,L_s}{l},$$

n being the number of revolutions per second, and l the lead. q' is the new value of q', and $q' + p' = q + p$.

Now, generally, σ is small compared with s; so that

$$\sigma : r + s = q' - q : p + q,$$

and

$$L_s = \frac{l}{n}(q' - q)\frac{r+s}{p+q}.$$

The two chief advantages of the cumulative method are—

(1) Impulses are turned into steady currents as far as galvanometers are concerned, and therefore null methods are applicable which would otherwise be impossible.

(2) The sensibility of the galvanometer is practically multiplied by the speed of the commutator. The only limit is that given by the ratio between the period of the commutator and the time constant of the network—*i.e.*, the time needed for currents to completely establish themselves. This renders it possible to much improve any existing null method, however good.

The sensitiveness of any of the above-mentioned difference methods depends upon three considerations—

(1) The sensitiveness of the arrangement of the bridge for the measurement of resistance.

(2) The time constant of the bridge.

(3) The amount of the difference measured.

Thus, in order to determine the ratio between L and M accurately by the method of fig. 6, it is necessary to remember that

$$L - a\,M = b\,D + \frac{\sigma}{N},$$

where D is the deflection caused by a small derangement from the null position, and a and b are constants; N is the speed reading of the secohmmeter, and σ the apparent increase of resistance. The most advantageous value of b will be given by (1) and (2), combined with the consideration that, other things being equal, it is best to have a as nearly equal to L/M as possible.

If the comparative methods of Maxwell can be rendered delicate by cumulation, all that is required for practical purposes is done, for we have good standards of capacity, and coils of wire having constant self-induction can easily be made. If, however, the effects are not accumulated, it seems as though no comparative null method of measuring these quantities can be more delicate than would be the measurement of resistance by a Wheatstone bridge, if it were only possible to touch the battery key for an instant. This process is employed when the bridge is far from balance, in order to prevent the effect on the galvanometer from being too great; and this is the process which must be used in the measurement of induction and capacity, since their effect vanishes after the first instant. Even the comparative method of Prof. Carey Foster, excellent as it is, could be much improved by using a cumulative method, not only because the galvanometer is rendered more sensitive, but also because a slight difficulty which renders a very exact balance impossible could be overcome—viz., unless the galvanometer is very ballistic, the condenser effect asserts itself before the mutual induction effect, and produces a slight "kick" on the galvanometer, which it is difficult to allow for accurately.

(To be continued.)

AFTER FIFTY YEARS.

THE day set apart for public rejoicing for the long and glorious reign of Queen Victoria will be with us ere another issue of the REVIEW is in the hands of its readers. For months past every news sheet which has spread itself before us, from whatever quarter of the realm it has emanated, has had one word and one idea written plainly across its pages—jubilee and jubilation—has had a considerable portion of its space devoted to details, grown nauseating by frequent repetition, of grand doings, local or national, to take place on that day of days. These same sheets, too, have given wide currency to many a rumour of intended honours for this and for that eminent nobody, or perhaps equally eminent somebody, who is for the nonce the fortunate representative of some more or less important section of the many-headed mass ; other rumours, less palpable and definite in form, but none the less assiduously promulgated, throng the air and make many a modest individual who, temporarily or permanently, fills a high position, nervous and miserable, whilst others, more ambitious but with less excuse for their anticipations, crane their necks and strive their hardest to seem an inch or so taller than their neighbours. Almost every association of Englishmen, of whatsoever kind or order, and no matter how slight or insignificant its bond and motive, has decided in some form or other to hold jubilee over the auspicious event to be celebrated next week. Amidst all this rejoicing, whether voluntary and genuine or prompted by interest, there is one remarkable circumstance, which, though it might never arrest the attention of the great outside world, must yet have become glaringly apparent to those of our readers who have bestowed more than a passing thought upon the Jubilee. One body of men —one Society which claims to represent that body in a corporate form—a body and a Society which above every other should at this juncture bestir itself to be in evidence, holds aloof in solitude, hides in the background, seemingly fears to lift its head or give forth its voice. A tiny whisper announced a few months ago that this was the fiftieth year of the electric telegraph as well as of Her Majesty's reign, and that the men who have made this great institution what it is, and who keep its wonder-working powers in effectual practice, would participate prominently in the general exultation of the period ; but the strong gale of the greater event soon eclipsed this very lightest breath of assertiveness, and no more has been heard of the jubilee of the telegraph. This is not as things should be. A great opportunity to distinguish itself has been afforded the Society of Telegraph-Engineers and Electricians, but it does not seem yet to have awakened to recognition of the fact. When it does awake it is possible that it may find that the opportunity has passed. At any rate, there is no time to lose, and we would commend to it, and to other electrical bodies, a few weeks of activity with the object of doing homage in a becoming manner to one of the great revolutionising forces of the century.

Having said so much to the electrical fraternity, we would now address a few words to those who represent the royal authority. Queen Victoria's reign, as we said at the outset, has been a glorious one : but what has constituted its glory ? Surely not the mere passage of years. That which will mark the Victorian era in years to come will be its great legislative efforts in the direction of political freedom, its literature, the extension of commerce, and the enormous advances made in the realms of science. It is just and proper that the men who have been instrumental in the emancipation of the people and who are responsible for whatever of wisdom and justice is to be found in the laws of the last fifty years should be singled out for high distinction : it is equally right, to our way of thinking, that those who have been foremost in creating the literature of the age, as well as those who have studied and worked for the development of science and industry, should be rewarded in corresponding measure. Yet, whilst mere politicians receive peerages and baronetcies, and knighthood is conferred upon a host of small people for no obviously sensible reason, the men who have done most to ameliorate the conditions of modern existence by applying to useful and industrial purposes the secrets yielded by the study of science—more particularly we speak of the men who have subdued all-powerful electricity and by its means annihilated time and space—are relegated to the outer chamber of cold neglect. It is not our province to point out individuals who are deserving of recognition for good and useful work done ; but it is an act incumbent upon us to issue a demand for fairness to those whom we represent. Honours of one sort and another are to be showered around during this period of joyfulness, and it will be nothing short of scandalous injustice if the claims of the deserving body of telegraph men are forgotten or ignored.

NOTES.

Temporary Electric Lighting at Chelmsford.—During the agricultural show at Chelmsford on the 7th and 8th inst., Messrs. R. E. Crompton & Co. gratuitously lighted the main street of the village. The lighting consisted of a circuit of about two miles of wire, as the works are some distance off. Twelve Crompton lamps were used, the power being supplied by a small Marshall engine. The insulated wires were carried down the street on ropes fastened from chimney to chimney. The lamps were also supported by ropes, and made a very effective combination with the numerous brightly coloured flags, with which Chelmsford was decorated. The whole work was done in 37 working hours, the fire escape being used for fixing the lamps. Another temporary installation was put up in the show ground itself, the dog show being artistically illuminated by six small Crompton lamps giving 500 C.P. each. By the courtesy of Messrs. Marshalls, the machinery was driven off one of their engines.

Electric Lighting in New York.—At their last meeting, the New York Aldermen adopted a report and resolutions to the effect that the gas commission for lighting the city be requested to contract for lighting the entire city with electric lights instead of gas.

Electric Lighting in the Navy.—On Wednesday night, the 8th inst., some very interesting experiments were made on board H.M.S. *Hero* at Chatham, the object of which was to afford the dockyard and naval officers an opportunity of comparing the respective beams of light thrown from two projectors, the one being fitted with a "Mangin" mirror, and the other with Ronald A. Scott's new mirror. At the conclusion of the trial the verdict was unanimously in favour of Scott's mirror, and Mr. Scott was warmly congratulated on his success. This exhibition had been specially sanctioned by the Lords of the Admiralty owing to the favourable report received from the Portsmouth officers, who have had Mr. Scott's mirror under trial, all such matters being referred to them for official trial and report. The lighting installation on the *Hero*, which consists of over 300 incandescence lights and four search lights, was carried out under the direction of Mr. Ronald Scott, who was complimented by the authorities at Chatham Dockyard on the satisfactory manner in which the ship was fitted.

Dynamos for the Navy.—The Admiralty has invited tenders for the supply of 34 sets of dynamos and engines, five of 400 ampères capacity, seven of 300 ampères, and 22 of 200 ampères, all the machines to have an E.M.F. of 80 volts. We hinted at this in our last issue.

Electric Lighting of Newspaper Offices.—We learn that the offices of the *Morning Post* are to be lighted by electricity.

The Proposed Lighting of Bucharest by Electricity.—Negotiations which have been going on for some time between the gas company at Bucharest and the Municipal authorities have fallen through. The Municipality favours the idea of introducing electric lighting, for the production of which a fall of water near Cotroceni would afford motive power. Before coming to a definite decision, however, the authorities have consulted a German engineer, and at present they are awaiting his report.

The Electric Light at Weston-super-Mare.—Not long since, Mr. H. G. Massingham, the managing director of the Taunton Electric Lighting Company, made an offer to the authorities at Weston-super-Mare to introduce the electric light to the town for one month, by way of experiment. It is considered probable that this favourable proposal will be entertained, and in view of the anticipated permission, arrangements are being made to light the sea front and the principal streets during July or August, when the town will be thronged with visitors.

House Lighting.—A small installation of electric light has lately been carried out by Messrs. J. F. Waddington & Co., Seacombe, near Liverpool, at the works and house of Mr. W. Mosley, Springfield, Cheadle. The installation consists of a Hill patent dynamo, driven from an engine in the works, and run during the day to charge a set of E.P.S. accumulators in the cellar of Mr. Mosley's house. The lamps being lit from the accumulators during the evening. The electroliers and fittings have been supplied by Messrs. Verity & Son. During the winter months when the dynamo has finished charging the accumulators, it will be used to light two arc lamps of 4,000 C.P. each in the works. The installation has been designed and its erection superintended by Mr. Claude W. Hill.

Liverpool and Telegraphic Delays.—A feeling of dissatisfaction on the part of Liverpool merchants on the score of extraordinary delays in the telegraphic service between that city and the continent found expression recently in a large and influentially-attended public meeting, over which Sir William Forwood presided. Illustrating the delays in question, Sir William said it was found quicker and more convenient to send telegrams for Bremen and Havre round by New York than to entrust them to the direct service of the postal authorities. Resolutions calling the attention of the Government to the serious inconvenience and loss sustained by the trade of the port in consequence of the great delays in telegraphic communication with the Continent, urging the Postmaster-General to appropriate special wires for the conveyance of messages from Liverpool direct to the Submarine Cable Company's offices in London, and suggesting an alteration in the system of registration of foreign telegrams at the London Post Office, were unanimously passed.

Telegrams to the Continent.—Mr. Montagu, on Monday, asked the Postmaster-General whether negotiations were now pending for the renewal of the monopoly of the Submarine Telegraph Company, which expired in 1889; and whether, before any final decision was taken, the conditions would be stated, so that the various Chambers of Commerce might have an opportunity of considering them. Mr. Raikes, in reply, stated that he was in communication with the telegraphic administrations of some of the neighbouring foreign States with regard to the arrangements which it would be necessary to make for the transmission of telegrams between this country and those States when the concessions now held by the Submarine Telegraph Company from France and Belgium expire in 1889. He did not think that he could promise to submit those arrangements to the Chambers of Commerce, but he should be ready to consider any suggestion that they might desire to make.

The Telephone in Tunis.—The telephone has been introduced into the French colony at Tunis, and lines have been extended so far that Marsa and Goulette have been connected by it with the capital.

Electro-Metal Extracting, Refining, and Plating Company, Limited.—Enquiries are being made by *Money* for a copy of the balance sheet of this company. "The reason we ask," says our contemporary, "is because we want to see what justification the directors have for issuing £5,000 in debentures as a first and exclusive charge on the plant, patents, and stock-in-trade of the company. It is stated in the circular inviting subscriptions to this issue that 'the company has practically no liabilities,' and also that a limited number of these debentures will be issued at par, after which they will be considerably advanced. We shall be glad if Mr. Thomas Fenwick, the managing director, will afford us some information respecting the company's position, and whether he considers the company is justified in raising this heavy mortgage. We pause for a reply, and, in the meantime, intending investors will do well to stay their hands."

Technical Schools.—Mr. E. C. Robins's book on "Technical School and College Building," will be published next week by Messrs. Whittaker and Co.

Railway Safety Appliances.—Messrs. Saxby and Farmer are exhibiting at their offices, 31, Parliament Street, Westminster, some of the most recent and important of their improvements in railway signalling and locking apparatus, which are well worth an inspection by any one interested in such matters. We are unable to find room this week for a description of them, but will endeavour to do so in our next issue.

Newcastle Exhibition.—Professor Garnett commenced the intended series of lectures in connection with the Exhibition, in the Theatre, on Saturday last, his subject being "The Electrical Appliances of the Exhibition." The lighting of the theatre was described, and the method adopted by the contractors, Messrs. J. H. Holmes and Co., for maintaining constant electric pressure. The application of electricity to haulage and other purposes was also referred to, and by a number of illustrative experiments, the subject was made interesting to a large audience.

Electric Experiments at Florence.—Some experiments with a photo-electric apparatus designed to throw a light a great distance, were carried out last Saturday at Florence, by military engineers, and were highly successful, the results obtained being considered most satisfactory.

Drake and Gorham's Cells.—The North British and Mercantile Insurance Company is supplementing the E.P.S. accumulator by a battery of 53 of Drake and Gorham's improved cells. The existing battery is placed in the basement, but the new cells are to be fixed on the roof, and arrangements will be made to run them either separately or in parallel with the old cells.

Secondary Battery Literature.—Many of our readers will be glad to learn that Mr. Reckenzaun has sent us a further contribution to his series of articles which have been running through so many numbers of the REVIEW. We hope that now he has safely arrived in the States, we shall not be again subject to so long a discontinuance of his papers.

The Cost of Electric Locomotion.—Mr. Elieson may take courage over his Stratford experiments. It has been found in Boston that the cost of the Julien system of propelling tramcars with electro motors and secondary batteries, comes out about 7 cents per car mile, as against 10 to 11 cents by horse traction. This entirely bears out the opinion of such experts as Mr. Reckenzaun.

The Newton Primary Battery.—A syndicate is in course of formation with the object of bringing before public notice the merits of the battery invented by Mr. Charles Maltby-Newton, of Maidenhead, and patented by him in 1885. We understand that it is not intended by the syndicate to supply batteries but to form a company to take over the proprietorship of the patents and manufacture. The advantage claimed for this form of battery is that valuable bye-products can be profitably reclaimed, and the proposed mode of working, therefore, is to supply batteries on rental, recharging at stated times and collecting the contents of the exhausted cells for treatment in the bulk. The negative pole is iron or copper, the positive is zinc, the depolariser is a plate of oxide of lead, and the exciting liquid is a caustic alkali. The cells have been tested and reported upon by Dr. Walmsley, late of the City and Guilds Technical College, Finsbury; but the whole affair looks to us too much like a repetition of the Lalande-Chaperon boom. We may probably refer to this again at greater length in our next.

Royal Society.—On Thursday the following papers were down for reading before this society :—"Experiments on the Discharge of Electricity through Gases" (second paper), by Prof. Schuster, F.R.S.; and "The Electromotive Properties of the Electrical Organ of *Torpedo marmorata*," by F. Gotch.

In re T. Tayler Smith.—The affairs of T. Tayler Smith, who was a surveyor and electrical engineer, carrying on business in Circus Place, Finsbury, London Wall, was before Mr. Registrar Hazlitt on Tuesday. The bankrupt applied to pass his examination. His liabilities were returned in the statement of affairs at £165,037, of which £9,093 were expected to rank, with assets £3,852. It appeared that in 1876 the bankrupt purchased the Bush Hill Park estate, Enfield, for £60,000, and subsequently assigned his contract to the Northern London Estates Company, Limited, in consideration of being appointed their surveyor. To his liabilities in connection with this company (which is now in liquidation) he attributes his own failure. The bankrupt was examined mainly in reference to his transactions with the company, and passed his examination.

Refining Zinc by Electrolysis.—Mr. Alexander Watt, author of "Electro-Deposition," "Electro-Metallurgy," &c., has lately patented a process for refining zinc, and extracting the metal from its ores, which he states presents some important advantages over the methods hitherto adopted for the same purposes. By the new process the zinc is obtained in a perfectly pure state, all the metals with which it is commonly associated becoming agglomerated in the form of a scaly film or spongy mass, insoluble in the electrolyte, upon the surface of the anodes; these metallic impurities are readily removed by being brushed off the anodes from time to time, and may be collected and recovered by well-known means, and thus rendered commercially available. The importance of pure zinc for use in voltaic batteries has long been recognised, since it is well known that much of the local action of voltaic couples is due to the presence of electro-negative metals in the ordinary commercial zinc; in this field alone, therefore, the new product should have an extensive demand. Pure zinc would also find a ready market for alloying with electrolytic copper to form brass of superior quality. We are informed by Mr. Watt that the cost of refining zinc by his process will be about £3 per ton. Some samples of zinc produced by the new process were lately shown to us, and they certainly exhibited a remarkably white colour as compared with commercial zinc. Respecting the extraction of zinc from its ores, but more especially from calomine, Mr. Watt states that he has obtained some highly satisfactory results, and is fully satisfied that he can reduce the metal electrolytically, at a cost which will leave a good margin for profit.

Proposed Electrical Exhibition in New York.—At the recent meeting of the New York Electrical Society, the electrical section of the American Institute, a project was discussed for holding an electrical exhibition in New York during the coming autumn. The idea received hearty approval, and steps were at once taken to ensure its being carried out. The exhibition is to be held in the Exhibition Hall of the American Institute, and is to include demonstrations of all the applications of electricity. No such exhibition has ever been held in New York, and a great deal of enthusiasm prevails regarding that projected.

The Scranton Electric Railway.—The president of the electric railway at Scranton, Pa. (Van Depoele system), reports under date May 24th : "Our three cars carried just about an even 10,000 people last week, and worked splendidly all the time." The traffic has increased so rapidly that two 25 H.P. motors and further generating plant have been called for.

Electric Motors in New York.—The Daft Company has latterly, we learn, been very busy meeting the demand for motors and for electric power, and has had to increase its steam plant, &c. It is also increasing its area of service, and is receiving excellent reports from its motors, which are now running on all kinds of work.

Electric Brakes.—A *résumé* of the results of the brake tests undertaken by the Chicago, Burlington and Quincy Railroad, says the *Electrical World*, shows that in this particular field, as well as in others, electricity will play an important part in the future. Even now it is clear that the best graduation of braking is accomplished by the use of electric devices, and the rapidity with which a train can be brought to a standstill shows in favour of electricity. The manner in which the current will be generated and the method of its application are, it seems, points still to be determined upon. We may, of course, use a dynamo for a generator, but batteries have been used on several of the trials. In the latter case both the open and closed circuit systems may be used. In the former case, the battery is only called on for work during the actual period of braking. But on the other hand, it has the disadvantage, not shared in by the latter system, that it gives no indication of irregularity in the condition of the apparatus. Various methods of overcoming this objection are in use, such as the placing of two batteries in opposition, one of which is temporarily thrown out of circuit. Other methods for this purpose will no doubt suggest themselves to our readers.

Electricians in America and the Queen's Jubilee.—A movement is on foot in American electrical circles for a celebration of Queen Victoria's Jubilee, on June 20th or 21st. There are many electricians of English birth or descent in that country who would like to participate in such a movement and to carry out the idea, and a committee has been formed as follows :—Mr. G. G. Ward, chairman; and Messrs. Leo Daft, Samuel Insull, T. C. Martin; and W. M. Callender, secretary. The celebration will probably take the form of a little dinner, followed by an amateur musical entertainment and speeches. It is believed that in this way a most enjoyable evening can be spent by the celebrants and their American friends. We had supposed it to be the intention of electricians at home to celebrate the concurrence of the Queen's Jubilee with that of the electric telegraph, but so little has been heard of any scheme that we are not at all sure whether anything definite has yet been settled or not.

The "Industries" Motor Competition.—In compliance with the suggestion given in the preliminary report of the committee of jurors, the proprietors of *Industries* announce that they intend to have two motors constructed from the designs marked "Agir" and "Ironclad," in order that their respective merits may be decided by a practical test.

Sale of Electrical Plant.—Messrs. Wheatley Kirk, Price, and Goulty will sell by public auction on the premises of the late firm of Messrs. Cordner, Allen & Co., Limited, Wandsworth Bridge Wharf, Fulham, London, S.W., on Thursday and Friday, June 23rd and 24th, 1887, commencing each morning at 11 o'clock prompt, the entire contents of the above works. The electrical plant comprises various instruments, cable, dynamos, arc and incandescent lamps, apparatus and fittings, &c., &c.

Portable Electric Lamp Wanted.—The engineers of the Prince Henry Railway Company, it is said, are casting about for a portable electric lamp with powerful reflector, directing rays of light capable of piercing the smoke from blasting, so as to permit of inspecting the roof of mine workings.

The Julien System of Electrical Transmission.—Mr. Pedro G. Salom, of Philadelphia, read a paper upon this subject at a meeting of the Franklin Institute on February 16th last. The paper is published in the *Journal of the Franklin Institute* for June.

Electric Safety Lamps.--Prof. Silvanus Thompson, utilising the opportunity afforded by the recent lamentable disaster in the Udston Colliery, has written to the *Times*, with the view of urging the early and enforced adoption of electric safety lamps in mines. Not even the most drastic enforcing of the recommendations of the Accidents in Mines Commission, he says, could insure immunity from explosions so long as colliery owners dare to employ lamps that can be opened by the men, and men are employed who dare to open their lamps. His object in writing, he says, was to point out that science has not yet spoken her last word in the matter. The employment of the electric safety lamp furnished the only really satisfactory guarantee against this fruitful source of disaster. Three years ago the adjudicators of the Ellis Lever Prize offered for a perfect safety lamp were reluctantly compelled to declare that no lamp submitted to them fulfilled the conditions of perfection laid down by the Miners' Union. As one of those adjudicators he could state that, out of the many lamps submitted to competition, only three were electric lamps, and these of very imperfect design. Since that date, however, several forms of electric safety lamps have been perfected. One of these was shown at the Birmingham meeting of the British Association by Mr. J. W. Swan, and he knew of the existence of several other thoroughly practical and reliable lamps. The electric safety lamp is, so far as he is aware, the only form of lamp that can defy the criminal folly which, to all appearance, was the cause of the recent "accident." Would not the appointment of a Royal Commission, he asks in conclusion, to supplement the work of the Accidents in Mines Commission by a special inquiry into electric safety lamps be a timely act ?

The Grosvenor Gallery Central Station.—A correspondent informs us that a week or so ago a lineman from this station was sent up a pole to attach a wire whilst the latter was in circuit, with the result that he received a severe shock, which caused him to fall from the top of the pole through the roof into some stables below, whence he was taken, badly injured, to the hospital. More recently, the engineer of the installation, the same correspondent states, was standing on a plasterer's box (which was wet), cleaning a switch with a piece of wood, when by some means his hand came in contact with one of the metal parts in circuit, and he was knocked into a tub of mortar.

Obituary.—The death is announced, at the advanced age of seventy-six, of Mr. Alex. Angus Croll, who was one of the founders of the United Kingdom Electric Telegraph Company, and represented that company during the negotiations for the sale of the telegraphs to the Government.

The Opéra Comique.—The late disaster and its consequences are by no means forgotten in Paris. At a recent meeting of the Municipal Council the following resolution was at once adopted : "Considering that gas-lighting in theatres and concert-rooms constitutes a permanent danger (better: *menace*) to public security, the Council resolves that a maximum limit of three months is allowed to all the theatres and concert-rooms of Paris for substituting the electric light for gas in all parts of the premises. Admission into any theatre or concert-room where this order is not carried into effect within the time accorded will be interdicted to the public." But the French government knows how not to do it. This resolution cannot be put in execution without the sanction of the Prefecture of Police. But this body remains silent. It has even made the retrograde movement of ordering the immediate suppression of the Jablochkoff candles at the Châtelet Theatre. This step is incomprehensible. The Jablochkoff candles, which have been use in that establishment for two years, are much less safe than glow-lights, but still far preferable to gas !

Elieson's Electric Locomotives.—The locomotive which we mentioned last week as being in regular operation on the Stratford-Manor Park tramway, is still running with one car attached, the total number of passengers carried up to the end of the first week being 7,335. Only one difficulty has been experienced, and this will soon be overcome ; that it should have occurred at all almost passes belief, but to this we shall probably refer in detail in the near future.

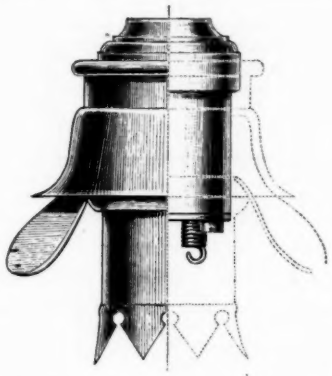
More Incandescent Lamp Litigation in America.—We learn that Dr. Woodward, the inventor of Woodward's incandescent lamp, is at present travelling through the States, obtaining special information with a view to institute proceedings against a number of firms for infringement of the Woodward patent rights, which are said to be in full force in Canada, Germany, and the United States of America, the former being granted in the year 1872, and the latter in 1874. This step has been taken in consequence of the recent decision in upholding the Nelson Green patents.

Recent Illumination at the Law Courts.—We are requested to state that the coloured lamps used at the recent meeting of the Incorporated Law Society were Shippey Brothers' patent low resistance lamps specially made to run in group series of 10 and 12 lamps on the Edison and Swan 100-volt circuit. This installation was successfully caried out by Messrs. Bailey and Grundy, and is good evidence of the value of a practical low resistance coloured lamp for decorative and illuminating purposes in places where electric light plant is already installed.

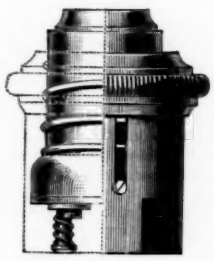
Jubilee Illuminations.—Among the applications of the electric light to outdoor illumination in celebration of the Jubilee, are the following which have been specially put up by Messrs. Woodhouse and Rawson. The Broad Street front of the New Stock Exchange is being fitted with incandescent lamps following the outline of the building. Above this are two devices of coloured incandescent lamps forming the letters "V. R." Again, above are two rows of incandescent lamps, and at the top four arc lamps. At Messrs. Huth's the outline of the portico is marked by incandescent lamps, and on either side of the door are the letters "V. R.," also in incandescent lamps. At the House of Mr. Clinton Dent, No. 6, Brook Street, are the letters "V. R." formed by small incandescent lamps, and at Dr. Elam's, 75, Harley Street, Cavendish Square, W., a combination of incandescent lamps with an arc lamp makes a striking effect.

We understand that Messrs. Faraday and Son, of Berners Street, are providing special designs in incandescent lamps for the Royal Institution, Messrs. Collinson and Lock, and Messrs. Duveen, in Oxford Street, and also for the fronts of several houses in Bruton Street, Mayfair.

New Lamp Holders.—The Walsall Electrical Company has brought out a new patent lamp holder which has a neat appearance, being smaller than other holders made for capped lamps, and by means of two series of springs—the buffer spring and the master spring—a smooth and regular contact is ensured. There is a great convenience in the wiring of this holder, the binding screws being placed in such manner that they



are reached readily from the front, thus obviating any necessity to take the holder to pieces for this purpose. For loop lamps the master spring has a reverse action and pulls the spring hooks into sure contact with the lamp loops. Its freedom from any breakable portions is another strong point in its favour. Though only just brought out it has found its way into one of the



largest London installations, namely, the recently-opened Hotel Victoria, Northumberland Avenue. It is also proving satisfactory at the Dudley Industrial Exhibition under the hands of the Walsall Company.

Electricity in the Royal Navy.—The 350 members of Parliament who, at the invitation of Captain Lord Charles Beresford, R.N., visited Portsmouth on Saturday, witnessed during the afternoon the explosion of two electro-contact mines, each containing two hundred pounds of gun-cotton by electrical means. On Monday the old hulk *Resistance*, one of the earliest types of ironclads, was attacked by a Whitehead torpedo, charged with over 90 lbs. of gun-cotton, which was attached to her side a considerable distance below her water line in the vicinity of the engine room on the starboard side. Unlike former tests, the result was a complete victory for the torpedo, which was exploded by means of an electric current controlled by a launch some distance away. A large hole was blown in the ship's bottom, and the *Resistance* rapidly filling with water sank on to the mead flats, from which precarious position it is considered probable that difficulty will be experienced in extricating her. As the section attacked was specially strengthened so as to represent a modern man-of-war, the experiment throws considerable light on the vexed question of torpedo warfare.

The Electro-Harmonic Society.—The fourth concert (smoking) which forms the last of the present series, will take place on Friday next. The programme can be seen by referring to p. 2 of Supplement, and it is hoped that members and their friends will be present in force.

Grievances of Telegraph Clerks.—Another meeting of the staff of the Central Telegraph Office was held at the Lecture Hall of the Young Men's Christian Association, Aldersgate Street, on Wednesday evening. Much dissatisfaction was expressed at the unfavourable replies received from the Postmaster-General in answer to the recent petitions from the staff. It was decided that a petition should be forwarded embodying the grievances of the entire staff, and praying that they may be accorded an increase in their pay, an extension of holidays as an equivalent for Bank holidays, and less arduous hours of duty, and, in fact, that they should be placed upon a similar footing to the civil servants in other branches. It was pointed out that the Jubilee day would be observed as a Bank Holiday by other branches of the Civil Service, but that, owing to the exigencies of the telegraph service, a large majority of the staff will be compelled to work as usual, for which they will receive no remuneration.

A Good Idea.—The Anglo-American Brush Electric Light Corporation has decided to admit one pupil free of a premium to its works. The vacancy is from time to time to be filled up by nomination of the City and Guilds Institute, under the recommendation of Professor Ayrton and Professor Silvanus Thompson, and subject to some special conditions of eligibility. Mr. John Rance, Jun., is the first nominee in accordance with this arrangement.

Medical Electricity.—At the recently established Electro-Dynamic Medical Institute, 21, Bloomsbury Street, Mr. William Lynd, its founder, has been lecturing on the place of electricity in medicine and explaining the *raison d'être* of the institute. He exposed electrical quackery and demonstrated the worthlessness of the advertised so-called electric-generators, brushes, and electrical belts. The object of the conductors of the institute was stated to be the scientific administration of electricity, due attention being paid to such matters as the strictest accuracy in the measurement of currents and exactness in modes of administration. The lectures were illustrated by practical demonstrations, the lecture-room being fully equipped with a number of very costly instruments and apparatus.

Students' Meeting.—The third and last (for the present season) of the very successful meetings of the students of the Society of Telegraph-Engineers and Electricians, was held on Thursday, the 2nd inst., Mr. W. Lant Carpenter, B.A., B.Sc., chairman. After a few remarks with reference to the action of the council in promoting students' meeting, the chairman called upon Mr. Woodingham to open the discussion upon Mr. Kapp's paper "The Predetermination of the Characteristics of Dynamos." Mr. Woodingham briefly described Mr. Kapp's method, and then gave an account of that used by Drs. Hopkinson, showing some curves representing calculated and observed characteristics. After which, Messrs. Rance, Hayne, Cooper, Healing, Dykes and Lamb continued the discussion. The chairman closed the proceedings after a vote of thanks had been passed.

Personal.—Mr. Alexander Bernstein, we hear, is going to America this week, and does not expect to return to England until the autumn.

We are very pleased to note the success of Mr. Telford Varley in the Cambridge Mathematical Tripos. Mr. Varley is the son of Mr. S. A. Varley, so well-known in connection with the discovery of the reaction principle of dynamos and the invention of the method of compound winding of their field magnets, now universally employed. Mr. Telford Varley's name occurs tenth in the list, but there was a bracket of four senior wranglers, and he is actually bracketed sixth in position. He was third in his own college, John's, the other two both securing senior honours.

NEW COMPANIES REGISTERED.

Anglo-Portuguese Telephone Company, Limited.—Capital: £50,000 in £1 shares. Objects: To carry on in all branches the business of a telephone, telegraph, and electric light, heat, and power supply company. Signatories (with 1 share each): R. Rodgers, 53, New Broad Street; T. Taunton, 72, Durham Road, Manor Park, Essex; C. Curtoys, 109, Farringdon Road; R. Herring, 84, Landsmere Road, Clapham; W. J. Antram, 268, Shirland Road, W.; G. P. Pike, 108, Lower Kennington Lane; J. S. Chisholm, 12, Pancras Lane, E.C. The first members of the London board are Sir Alexander Armstrong; Frederick Clift, Esq., LL.D.; and Arthur Henry Baker, Esq. The members of the Lisbon board are Conde de Gouvea, Conde de Lumiares, Senhor Barbosa Collen, Senhor E. Pinto Basto, and Senhor Jorge O'Neill O'Neill. Directing qualification: £100 in shares or stock. Remuneration: £600 per annum to the London board, and £500 per annum to the Lisbon board; an additional sum of £100 per annum will be allowed for the services of a secretary to the Lisbon board. Registered 8th inst. by Linklater & Co., 7, Walbrook. Registered office, 53, New Broad Street.

Holmes Light Company, Limited.—Capital: £2,500 in £10 shares. Objects: To acquire the letters patent, No. 3,490, dated 18th February, 1884, granted for improvements in inextinguishable signal lights, and to carry on the business of manufacturing and selling life-saving apparatus, and all electrical apparatus for submarine purposes. Signatories (with 1 share each): D. R. Comyn, 37, Cornwall Road, W.; W. F. Topping, Wanstead, Essex; T. Waller, 15, Billiter Street; J. Birnice, 25, Belmont Park, Lee; J. Nattruss, 121, Fenchurch Street; T. R. Ord, 52, Lime Street; J. W. Howard, 78, Queen Victoria Street. Registered 8th inst., without articles of association, by W. Tyndale Moore, 26, Great St. Helens.

United Telephone Company of Rosario, Limited.—Capital: £20,000 in £10 shares. Objects: To take over the undertaking of the "Compania Telefonos Unidos del Rosario" (a company established in Rosario, Brazil), upon terms of an agreement entered into with the River Plate Trust, Loan, and Agency Company, Limited. Signatories (with 1 share each): H. E. Hudson, 64, Moray Road, N.; F. H. C. Butell, Loughton, Essex; W. Hamilton, 12, The Avenue, Brondesbury; W. Dixon, jun., Board School, Aldenham Street, St. Pancras; H. P. Gilbert, 51, Bassein Park Road, Shepherd's Bush; E. T. Botwright, 23, Sutton Place, Hackney. The subscribers are to appoint the first directors. Qualification: 20 shares. Registered 13th inst. by Ashurst, Morris, Crisp & Co., 6, Old Jewry.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Westinghouse Engine Company, Limited.—An agreement between Arthur George Brown and this company cites that the vendor will procure for the company the rights as to manufacturing and selling Westinghouse engines, which Messrs. Alley & MacLellan are now entitled to, and he will sell to the company the following letters patent, viz., No. 10,937, of the year 1884; No. 13,293, of 1886; No. 16,966, and the inventions for which the letters patent, Nos. 5,134 and 5,135, of 1887, have been applied for; and also all the Westinghouse engines in course of manufacture at the date of registration by Messrs. Alley and MacLellan in the Sentinel Works, Polmadie, Glasgow. The purchase consideration is £30,000—payable £10,000 in cash and the balance in fully-paid shares.

Electric Locomotive and Power Company, Limited.—An extraordinary general meeting of this company was held on the 11th ult. at the works of the company, Macintosh Lane, Homerton, when it was resolved to wind up the company voluntarily with a view to reconstruction, and Messrs. Thomas Wickham, of Cromwell House, Leytonstone, and J. J. Griffiths, of 7, Highbury Grange, were appointed liquidators. The resolutions were confirmed on the 27th ult., and duly registered 7th inst.

Electric Portable Battery and Gas Igniting Company, Limited.—The Chancery Division of the High Court of Justice has ordered the winding-up of this company, upon the petition of Messrs. J. H. Stretton and J. A. Hilliard, of 75, Cornhill, solicitors, creditors of the company. The order, dated 21st ult., was filed on the 9th inst.

CITY NOTES.

The Northern District Telephone Company, Limited.

THE fifth annual general meeting of the shareholders of the Northern District Telephone Company, Limited, was held at the offices of the company, Arcade Chambers, on Monday. After the report of the directors and statement of accounts had been read and adopted,

The Chairman, Mr. R. T. Wilkinson, pointed out the very satisfactory progress which the company had made since the beginning of the present year. In view of the great dulness in trade and the consequent reluctance on the part of firms to increase their expenditure even by so small an item as an annual telephone rental, he considered the number of subscribers to the company's exchanges to have increased with a rapidity which was extremely satisfactory, the total number at the end of 1886 showing the increase for the 12 months to have been at the rate of no less than 71 per cent. Adverting to the recent increase in the company's capital from £100,000 to £200,000, the chairman pointed out, as an instance of the confidence shown in the company, that the whole of the new capital had been taken up immediately it was issued. This he considered to be extremely gratifying. He was also glad to see that a very considerable extension of the system had been carried out, and he had every reason to believe that it would soon make them a very remunerative return. He felt certain that the year 1887 would prove equally as satisfactory to the shareholders, in the matter of increased business, as the last year had, and that notwithstanding the continued depression in trade.

The payment of the preference dividends having been confirmed, and the usual vote of thanks to the chairman passed, the meeting terminated.

The Eastern Telegraph Company, Limited.—The directors are prepared to issue the four per cent. debenture stock (bearing interest from May 1st, 1887), in exchange for equal amounts of the company's five per cent. debentures falling due August 1st, 1887, with the coupon due that day attached, and to pay £1 in cash in respect of the said coupon if the debentures are deposited at the company's office on or before July 1st, 1887.

The United Telephone Company, Limited.—The directors, subject to audit, recommend a dividend for the second half year ending April 30th last at the rate of 8s. per fully-paid share (part-paid shares receiving in proportion), making, with the interim dividend, a total dividend for the 12 months of 13 per cent., less income tax.

African Direct Telegraph Company, Limited.—Notice is given that on and after Monday, the 20th inst., the offices of this company will be removed from 8, Great Winchester Street, to Winchester House, 50, Old Broad Street, E.C.

Brazilian Submarine Telegraph Company, Limited.—Notice is given that on and after Monday, the 20th inst., the offices of this company will be removed from 8, Great Winchester Street, to Winchester House, 50, Old Broad Street, E.C.

The Great Northern Telegraph Company, Limited.—This company announces the payment of an interim dividend on its shares at the rate of 5 per cent. per annum.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 10th were £3,404, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending June 10th amounted to £4,151.

NEW PATENTS—1887.

8214. "Telephone systems." W. P. THOMPSON. (Communicated by E. Mauritius.) Dated June 8.

8262. "Electric generators." W. M. MORDEY. Dated June 8.

8267. "Working and controlling electric currents." I. A. TIMMIS, D. HALPIN. Dated June 8.

8284. "Electro-deposition of the heavy metals." S. P. THOMPSON. Dated June 9.

8311. "Sash fastener for use in connection with electrical alarm apparatus." K. A. REISERT. Dated June 9.

8329. "Combination of parts of telephonic and electric bell signalling instruments." W. E. LANGDON. Dated June 10.

8333. "Bleaching paper pulp, &c., by electrolysis." J. TAKAMINE. Dated June 10.

8380. "Operating tramcars by electricity." A. L. LINEFF, W. JONES. Dated June 10.

8396. "Electrical apparatus for preventing corrosion or incrustation of steam boilers, &c.; removing incrustation when formed." A. J. MARQUAND. Dated June 10.

8433. "Telephone apparatus without a diaphragm." F. W. NEALE. Dated June 11.

8443. "Electrolytes for electric batteries." R. MCKENZIE. (Communicated by H. Weymersch.) Dated June 11.

8453. "Double-acting electric generator." THOMPSON, DOWSING, and REW. Dated June 13.

8495. "Electric lamps." A. M. CLARK. (Communicated by C. Berton.) Dated June 13.

8500. "Conduits for electric wires or cables." R. S. WARING. Dated June 13. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

3675. "Improvements in transmitting motive power from electro or other motors and apparatus therefor." J. GIBSON. Dated March 16. 8d. The inventor employs two tapered drums or cones, placing the greatest diameter of the one opposite the least diameter of the other, constructed so as to give any required reduction of speed by increasing or diminishing the diameter of said cones to suit any number of revolutions required. The claims are 3 in number.

3945. "Improvements in electrical switches." R. M. BAILY, Jun., and A. GRUNDY. Dated March 20. 8d. The switch consists of two concentric, circular parts, one of which is fixed and the other free to revolve either through a complete revolution or partially. Upon the stationary circular part are two terminals or contact pieces connected by binding screws to the wire carrying the current. A contact piece of suitable form is attached to or forms part of the revolving portion of the switch, so formed and adjusted that the opposite ends of it leave the stationary contact pieces at exactly the same instant. The electrical contact between these movable parts and the fixed contact points is secured by a spring or springs. The whole of the above parts are mounted upon a suitable base and contained in a circular casing, which may be either stationary or may revolve, carrying the contact piece with it. The claims are 3 in number.

3946. "Improvements in the method of and apparatus for transforming the conditions of electric currents." L. BOLLMANN, E. BIEDERMANN, and D. MONNIER. Dated March 20. 11d. Claims:—First. A commutator or its equivalent in combination with closed electro-magnets, substantially as shown and described, which are intermittently or alternatingly magnetised by the primary current that passes through a number of the coils of the said magnets connected with each other in series, while the other coils of the magnets are connected in parallels to each other with the secondary circuit to lead of the current induced therein, by the said change of magnetism in the iron, which is caused by the primary current, as set forth. Second. A commutator, or its equivalent, in combination with the coils of the electro-magnets, whereby the currents from some of the latter pass one after the other on one side into the primary circuit, while currents from other of the coils pass in like order on the other side into the secondary circuit, substantially as described, and whereby the primary and secondary currents flow uninterruptedly and continuously as set forth. Third. The arrangement of the commutator brushes with the cables leading to the coils of the magnets, substantially as shown and described, whereby the primary and secondary currents are caused to flow successively through each coil always in the same direction. Fourth. The connection of the brushes, or their equivalents, with the electro-magnets, substantially as described, the currents coming through one brush passing through two, four or more coils, which belong to different ring magnets, before passing off through the next brushes for the purpose of reducing the sparks, as set forth. Fifth. The application of two sets of coils or series of coils on each magnetic rod, or its equivalent, as herein set forth, the principal current passing through one set while the secondary current passes off in the opposite direction through the other set, as hereinbefore described. Sixth. The brushes with their holders, substantially as described, their plates or wires constituting the brush, being placed radially or nearly so to the circumference of the commutator, and at an angle to the axis, substantially as set forth.

4308. "Improvements in dental engines operated by electricity." A. KIRBY. Dated March 27. 8d. Claims:—1. In the construction of electric motors of the horseshoe type for the purposes aforesaid, the method of forming pole pieces to fixed and revolving magnets, substantially as described and shown in the drawings. 2. In the construction of electrical motors for the purposes stated, the application and use of governors, substantially as described and partially illustrated on the drawings. 3. In the construction of electrical dental engines as described, the method of and means and appliances for making and breaking contact, substantially as described and illustrated on the drawings. 4. The general construction of the several and respective parts, and the combination of any two or more of them, constituting the improvements in dental engines operated by electricity, substantially as described.

4663. "Improvements in electric generators." F. F. STOGERMAYR and V. GLASSNER. Dated April 2. 8d. Claims:—1. A magneto-electric current generator consisting of three coils with iron cores arranged in the same axial line, both outer bobbins being inserted in the circuit of an electric generator containing a circuit closer, and so arranged that their cores upon magnetisation present different poles to the core of the central bobbin inserted in the working line. 2. Enclosing the three bobbins mentioned under claim (1) in hollow iron cylinders around which is led a circuit branching from the working circuit in such a manner that these hollow cylinders are of different polarity to the iron cores; the arrangement of the branch circuit being such that it also intensifies the effect of the primary current. 3. A commutator for converting the alternating into a continuous current consisting of a disc of insulating material fixed on the shaft of the circuit closer and carrying at both edges of its cylindrical surfaces metallic rings with equidistant contact projections springing towards each other, and equal in number to the teeth in the circuit closer, in combination with springs which form the terminals of the alternating current, and two forked springs which are connected with the terminals of the working current and slide upon the current projections of the rings which break joint with one another so that each is alternately thrown into contact at the right and left and that one spring only has contact with the projections on a ring at a time. 4. An automatic regulating rheostat by means of which the current driving the electro-motor for the circuit-closer is maintained constant, consisting of a cord running over a pulley and carrying at one end a solenoid core, and at the other end a metallic rod which is connected to the line and dips into a liquid of low conductivity, the whole so arranged that the attraction exercised on the cord by the solenoid and the weight of the core counterbalance the weight of the metallic rod, minus its buoyancy.

5588. "Improvements in dynamo-electric machines." W. M. MORDEY. Dated April 22. 8d. Claims:—1. In an armature of a dynamo-electric machine of the ring or ring disc type the combination of an inner portion consisting of a close volute of strip iron or of two such volutes side by side having a slight air space between them, with or without lateral projections extending between the coils towards the poles, and an outer portion consisting of thin iron rings or washers with or without projecting teeth or cogs, substantially as described. 2. The construction of ring, drum, or cylinder dynamo machines, substantially as described.

10502. "Improvements in the construction of electrical storage batteries." E. FRANKLAND. Dated August 16. Relates to the battery described in the No. of the REVIEW for April 22nd, 1887.

CORRESPONDENCE.

The Explosion of Glow Lamps.

I have on two or three occasions witnessed the explosion of glow lamps when the current was first put on. The following from Mr. R. Davids, Campinas, Brazil, is interesting—

"I was nearly blinded by the first 50 C.P. lamp I connected. Although I was merely connecting it to the spiral springs on the holder, without forcing in the least, it burst in my face, and filled my eyes with glass dust. Fortunately, in a day or two the effect passed off. I opened my eyes in a basin of water, without rubbing them."

I have attributed this effect to a slight leakage in the glass, and the consequent formation within the

lamp of an explosive compound of air and the remanent hydro-carbon gas used in flashing. Can any of your readers furnish a better explanation?

W. H. Preece.

The Upward Battery.

I have just seen an article in your issue of April 15th on "Local Action in Batteries," by J. E. Pearce, and I hope it is not yet too late to correct what may give to some of your impractical readers an erroneous idea of the Upward battery.

If this should be the same J. E. Pearce who was originally employed on the manufacture of the Upward battery of the earliest type (and I have every reason to believe it is), the result of his own experiment, or rather experience, can be easily explained in a far more practical manner than Mr. Pearce's local action. The whole phenomenon was simply the result of disobedience and carelessness; for instead of using a long-necked funnel and pouring the water in from the bottom of the cell as ordered, he used an ordinary jug and poured it in from the top; by pouring the water in at the bottom of the cell, it will naturally rise, being lighter than chloride of zinc, and as it rises the two liquids will mix, consequently causing a uniform specific gravity, also resistance. When this is attended to, I am in a position to say that the plates will go in absolute uniformity; this experience is gathered from absolute facts. When water is simply poured in from the top, the two liquids will not mix for some considerable time, so that with each addition of water the lower solution will be gradually increasing in specific gravity; the lowest resistance, chloride of zinc solution has a specific gravity of 1·35, so if you have specific gravity 1·6 in the bottom and nearly pure water at the top (which is always the case if water is added in the above way) it is not unnatural that the plates should go in the shape of a double wedge with the sharp edges joined, as that part of the zinc plates in the lowest resistance chloride will be doing most of the work.

I am anxiously looking out for the proposed improvement, but I hope Mr. Pearce will not add to the already too-numerous quackeries of the trade to the detriment of a really genuine article, or again attribute his own carelessness to a bad point in anything.

Henry Harper.

Altona, Germany,
June 10th, 1887.

Telephone Patents.

I shall be obliged by some of your contributors answering the following questions:—

(1.) What is the "English Mechanic" type of telephonic receiver? Is it covered by patent rights? If not, why?

(2.) Wherein does the patent lie for "Gillett's," "Stanhope," and "Silvanus Thompson" telephones"? and in what do they differ from each other?

(3.) Can the E. M. type of receiver be used in combination with a microphonic transmitter, provided the latter does not possess a diaphragm (?)?

4. Will any one venture to state what a diaphragm is supposed to be, firstly, in the eyes of an electrical scientist, and, secondly, in the eyes of a Patent Court judge.

"Puzzled."

[Doubtless some of our readers can briefly give the information here required, and if our correspondent desires it, he can see a copy of the *English Mechanic*, containing the description of the instrument called by that name, at our office.—EDS. ELEC. REV.]

Telegraphing without Wires.

In the last number of your excellent publication you mention the interesting experiments which Mr. Edison has been for some time undertaking to effect the transmission of sounds or of signals analogous to those of Morse across an arm of the sea several miles in width.

You rightly ascribe a great importance, even to a partial solution of this problem, with reference to the safety of ships.

The interest which you testify in the question, and which your readers will not fail to share, induces me to communicate to you some information on the history or the genesis of the idea.

By a curious coincidence, M. Somzée, the Belgian engineer, who has already been parallelled with Mr. Edison on the occasion of the invention of the glow lamp, seems in this matter again to have anticipated the American inventor, at least if we take account of the date of a patent which M. Somzée took out in 1870 for the same system of transmission.

The circumstances which at that time surrounded communication between Paris and the outside world with numerous difficulties, suggested to M. Somzée the idea of establishing between two distant points a system of telegraphic communication without the intervention of conducting wires.

This method of communication was mainly based upon the utilisation of derivations through the soil, and was experimented upon on a vast scale.

The details of the arrangement adopted by Mr. Edison not being yet known, it would be hard to say if the means employed by this inventor differ appreciably from those brought into use by the Belgian engineer. As we have in our hands merely the arrangement of this latter, we shall confine ourselves to giving some extracts from his patent, the origin of which goes back twenty years, which would lead us to believe that the illustrious American has not been the first to work at this subject.

Belgian patent, No. 28,297, December 8th, 1870, granted to M. Somzée for a system of electric telegraphy.

"The system consists in the use of the soil, of continuous strata or layers of rock or homogeneous earth, or watercourses, lakes, seas, or arms of the sea, as electric conductors employed simultaneously with one or more metallic wires interposed, permitting the derivation of the currents.

"This derivation of currents in the natural conductors above-mentioned by the intervention of metallic conductors renders it possible in their course to collect the electric and magnetic effects produced at any point of the circuit by means of recipient apparatus, and reciprocally to send from these latter sounds, signals, or dispatches.

"This system depends on the conductivity of the soil, of rocks, of waters, and metals, and especially on the different conductivity of these elements among themselves.

"To facilitate the transmission of the current, the telegraphic offices should be connected with the soil, river, lake, or sea by means of large powerfully conductive metallic plates.

"The application of this system would allow of a notable economy of metallic wire in the installation of ordinary telegraphic lines. A town situate in the geological conditions described might, even if invested on all sides, maintain a service for the reception and transmission of telegrams, without the enemy being able to interpose any obstacle. Paris, for instance, might utilise the arrangements indicated in fig. 3; figs. 4 and 5 represent the communications between the two shores of an arm of the sea, &c., or with an island and a ship on its course."

[This letter is undated and the signature is illegible, but it is written on the official paper of the *Grand Concours International des Sciences*, &c., Brussels. Did not one, James Lindsay, read a paper on this subject before the British Association at its Southampton meeting, and telegraph without wires across the Southampton water and across to the Isle of Wight? We also learn that an acquaintance of his, S. F. Fox, sent signals without wires across an ornamental piece of water in the Sheffield Botanical Gardens in the autumn of 1855.—EDS. ELEC. REV.]